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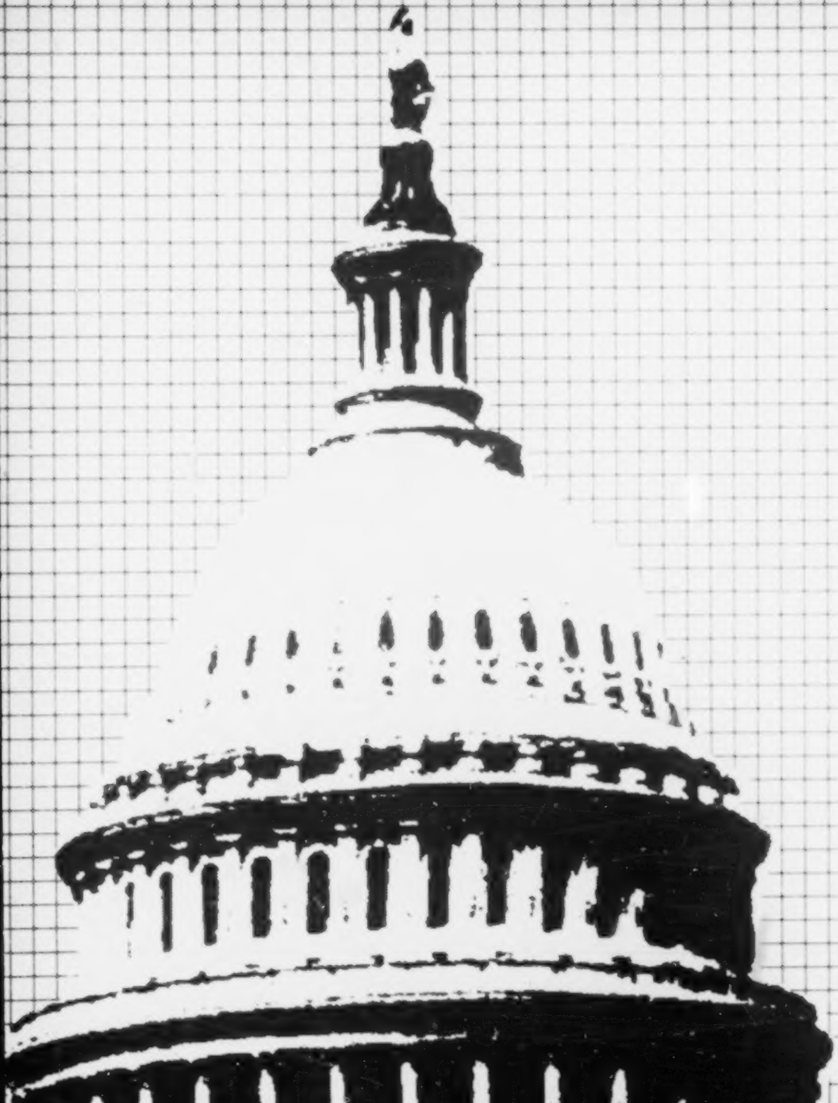
AAAS REPORT XVII

RESEARCH AND DEVELOPMENT FY 1993



Intersociety Working Group

AAAS
REPORT
XVII

RESEARCH
AND
DEVELOPMENT
FY
1993

Intersociety
Working
Group

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
Committee on Science, Engineering, and Public Policy
1333 H Street, NW, Washington, DC 20005

The AAAS Board of Directors, in accordance with Association policy, has approved publication of this report as a contribution to the understanding of an important process. The interpretations and conclusions are those of the authors and do not purport to represent the views of the Board or the Council of the Association.

Printed in the United States of America

International Standard Book Number 0-87168-441-4
AAAS Publication Number 92-10S

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(James R. Welty, Chairman)

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Preface

Scientific research and development (R&D) are of vital importance to the United States in the 1990s. The federal government supports nearly half of the nation's R&D, and its policies profoundly affect the institutions in which this work is carried out. The President's annual budget and the congressional debate that ensues are the mechanisms through which policies and priorities for R&D are set. Since 1976 the AAAS has published annually a report analyzing R&D in the proposed federal budget in order to make available to the scientific and engineering communities and to policymakers timely and objective information about the Administration's plans for the coming fiscal year.

This book is the seventeenth in the series of AAAS R&D Reports. The effort was begun in-house at AAAS by Willis H. Shapley, under the auspices of the Committee on Science, Engineering and Public Policy. It is now a collaborative effort involving contributors from 23 scientific, engineering, higher education, and industrial associations known collectively as the Intersociety Working Group.

This report is based upon the President's proposed budget for FY 1993, which was released on January 29. The format was again a single mammoth volume of about 2,000 pages. Even budget "insiders" on Capitol Hill have found recent years' budget documents confusing and difficult from which to extract needed information. However, the budget book's treatment of R&D budget matters has, if anything, improved over the past few years. This year's budget book again contained a well-written, analytical chapter covering most federally supported R&D, "Enhancing Research and Development and Expanding the Human Frontier." This more integrated and coherent treatment of R&D budget issues provides accessible coverage for the non-specialist reader.

This report is one of several publications and activities of the AAAS R&D Budget and Policy Program. In addition to functioning as a stand-alone document, the report serves as background for the Seventeenth Annual AAAS Colloquium on Science and Technology Policy held in Washington, DC on April 16-17, 1992.

A new annual volume, the *AAAS Science and Technology Policy Yearbook*, has replaced the old Proceedings of the S&T Policy Colloquium as the second publication in the R&D Program's annual series of three publications. This book contains most of the major Colloquium addresses, as well as both original and previously published articles by leading figures in science and technology policy. The third publication appears in the fall or winter, after Congress has completed its appropriations process. At that time AAAS, in collaboration with the Intersociety Working Group, will publish its annual review of the impact of congressional decisions on R&D, *Congressional Action on Research and Development in the FY 1993 Budget*. Registrants for the Colloquium will receive copies of all three of these publications.

The structure of this report parallels that of recent editions. Part I, the overview, includes discussions of the budgetary context of R&D and major funding trends, as well as analyses of funding for basic research and R&D in colleges and universities. Chapters on R&D in industry and funding for science, engineering and mathematics education are also included in Part I. Although neither of these is concerned strictly with R&D in the federal budget, each deals with closely related funding and policy matters that help define the context within which federal R&D is discussed and debated. A set of overview tables appears at the end of this section.

The chapters in Part II examine the proposed R&D budgets of major federal agencies and departments. Tables detailing those budgets and the budgets of several smaller agencies and departments not included in the chapters are included at the end of Part II.

Finally, Part III consists of a set of cross-cutting analyses that look at the budget in terms of disciplines and areas of research.

Readers should be aware that the chapters in this report have been prepared largely independently of one another and under extremely tight deadline pressure. Although every effort has been made to avoid them, some overlap, errors, and inconsistencies among the chapters are, unfortunately, inevitable.

On behalf of the members of the Intersociety Working Group, we would like to express our appreciation to the officers, members, and staffs of the participating organizations for their support and assistance in preparing this report. Our thanks also to the AAAS Committee on Science, Engineering and Public Policy, which initiated the R&D Program and periodically reviews it and provides guidance to it. We are very grateful to the individuals in the Office of Management and Budget, in other federal agencies, on congressional staffs and elsewhere, who aided us in collecting the information and advised us on its interpretation. We also owe special thanks to several AAAS staff members for their dedication and heroic efforts in preparing this volume for publication: Shirley Young and Elizabeth Broughman of the Directorate for Science and Policy Programs; Beth Goodrich of the Directorate for Education and Human Resources; and Kathy Fishback of the Office of Publications. Our sincere gratitude also goes to Darrow Tyler, whose skills, conscientiousness, and good humor were significant factors in completing this project on time.

Albert H. Teich
Stephen D. Nelson
Kathleen M. Gramp

Washington, DC
March 1992

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GENERAL NOTES

BASIS OF BUDGET STATISTICS

Budget statistics are presented on three bases: (1) **budget authority**, corresponding to the funds appropriated each year; (2) **obligations**, indicating the amounts of contracts and grants entered into; and (3) **outlays**, representing the amounts actually expended. Because budget decisions in the Executive Branch and in Congress are almost always made in budget authority, this basis most accurately reflects current changes in budget policies. Outlay trends lag a year or more behind decisions in budget authority, and obligations estimates are often adjusted to meet fiscal or budget strategy demands. We have, therefore, selected budget authority as the most meaningful measure of budget decisions and trends and used it in nearly all cases throughout the report.

BASIS RESEARCH, APPLIED RESEARCH, AND DEVELOPMENT

The allocation of agency budgets among basic research, applied research, and development is not an exact procedure; a certain arbitrariness is inevitably involved. The severe time pressures under which these figures are compiled for OMB are also a problem. Nevertheless, there is presumably some consistency within each agency's estimates so that the trends are meaningful.

ROUNDING NUMBERS

Due to rounding in the tables, the detail may not add to the totals, and the percentage changes may not correspond exactly to the difference shown.

Part I: Overview

Chapter 1

Overview and Policy Issues for FY 1993

American Association for the Advancement of Science

Kathleen M. Gramp
Albert H. Teich, Stephen D. Nelson

Overview

The Bush Administration has proposed that the government invest $75.7 billion in R&D in FY 1993, 3.3 percent more than appropriated for FY 1992 -- just enough to keep pace with inflation. Funding for defense R&D would rise 1.3 percent to $43.3 billion (down 2 percent in constant dollars); this represents 57 percent of the government's R&D resources. The $32.5 billion requested for nondefense R&D represents a 6.1 percent gain, or 2.7 percent after adjusting for inflation.

Initiatives targeted to special issues would garner most of the growth. Over $8 billion of the FY 1993 R&D budget has been assembled into four initiatives of the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET): Global Change, Biotechnology, Advanced Materials and Processing, and High Performance Computing and Communications. Other projects, such as the Space Station, Superconducting Supercollider (SSC), and Strategic Defense Initiative (SDI) account for another $8.2 billion. These sums represent a combined net increase of $2.4 billion over current levels, which is equivalent to the entire increase proposed for R&D.

In practice, these targeted activities are part of the ongoing R&D efforts -- and budgets -- of individual agencies. Viewed from an agency perspective, the President would award the largest gains to the Department of Defense (DOD, up $925 million, or 2.4 percent), National Aeronautics and Space Administration (NASA, up $747 million, or 8.7 percent), National Institutes of Health (NIH, up $434 million or 5.1 percent), and National Science Foundation (NSF, up $443 million or 21.5 percent). Other agencies would lose funds, notably the Departments of the Interior (down 7.5 percent), Agriculture (USDA, down 6.3 percent), and Energy (DOE, down 1.9 percent).

Political and Economic Context of the FY 1993 Budget

"Hurry up and wait" may be the watchword of the FY 1993 budget cycle. President Bush released his budget a week ahead of schedule, but held back details on his defense budget until the end of February. At this writing, Congress is on track to meet the President's March 20 deadline for action on an economic stimulus package, but few expect a veto-proof bill anytime soon, if at all. And all bets are off when it comes to appropriations: the strict caps adopted in 1990 for discretionary spending (which includes all R&D) could prove unworkable, raising the prospect of a protracted debate about tax and spending policies in a presidential election year.

Political handwringing may be inevitable given the complexity of the issues. Both political parties want to revive the economy, which has failed to rebound from the 1991 recession as quickly or as strongly as economists had predicted. Yet there is deep disagreement between and within the parties on how this could be done. Reconfiguring the U.S. military to reflect the post-Soviet world order is no small task. Assuming both sides could agree on the size of a "peace dividend," they would then have to decide whether to spend it (on programs, tax cuts, or both) or use it to reduce the government's swelling debt burden.

President Bush's $281.6 billion request for all defense discretionary spending at signalled that the military budget can decline faster and steeper than previously assumed. At this level, new budget authority for discretionary defense functions would be $5.8 billion below the FY 1993 cap, and an estimated $7.9 billion below the outlay target. The Administration wants these savings applied to deficit reduction, rebuffing calls from Congress to reconsider the splits between defense and domestic spending.

For lawmakers, however, the pressure to spend any peace dividend will be intense. According to a January 1992 analysis by the Congressional Budget Office (CBO), the cap on domestic discretionary spending is far more austere than envisioned when the limits were set in 1990. CBO estimated that adhering to the $205.1 billion cap on domestic spending would require appropriating $6.2 billion (or 3 percent) less than would be needed to stay even with inflation. Outlays would have to be cut $8.8 billion.

Some, but not all, of the outlay squeeze is of Congress' own making. To meet the domestic cap for the current fiscal year, lawmakers delayed the obligation of an estimated $4 billion until the end of this fiscal year, shifting an estimated $1.4 billion in outlays from this year to FY 1993. Technical quirks add to the problem. (For details on how Congress shaped the FY 1992 budget and its impact on R&D, see *Congressional Action on R&D in the FY 1992 Budget,* published by AAAS in December 1991.)

Simple arithmetic shows that the President's defense savings would take care of most of the shortfall in the domestic discretionary category. The political equation will not be that easy to solve, however. Opposing such a transfer, the Administration chose to stay within the domestic cap by "freezing" budget authority at $203.1 billion, a 4 percent cut relative to CBO's inflation-adjusted baseline. This freeze would come largely at the expense of programs funded through the Interior and Transportation appropriation bills, as well as over a half-billion in "unspecified" cuts. The initial budget measures being drafted by congressional Democrats would not only tap defense to pay for domestic needs, but cut defense even further to trim the $327 billion deficit projected by CBO for FY 1993.

R&D is likely to figure prominently in this debate. The amounts requested for R&D would absorb roughly 14 percent of the outlay caps for the defense and non-defense categories in FY 1993, up from about 12 percent of the discretionary expenditures in FY 1991. Tables I-1 and I-2 put this trend in historical context. (While the budget classifications presented in these tables do not precisely track the "discretionary" categories used in the current budget process, they reveal similar trends.)

R&D's share of total federal outlays has inched up in recent years, reflecting congressional and Administration priorities. Table I-1 suggests that in FY 1993, outlays for R&D would outpace the growth in expenditures government-wide. Outlays for defense R&D would go up 4.1 percent in a year when military expenditures are headed down 5.2 percent. Nondefense R&D would do the same, rising 5.9 percent while outlays for all "other government" programs would decline 1.2 percent.

Since FY 1980, R&D has steadily increased its share of defense outlays from 11.2 percent in FY 1980 to 14.6 percent in FY 1993. While 14.8 percent of "other government" outlays in FY 1993 would be devoted to nondefense R&D, this share remains well below levels invested in FY 1970 or FY 1980 (26.5 percent and 19.2 percent, respectively). And because of the rising demands of interest and entitlement payments, R&D would represent only 4.8 percent of total federal outlays in FY 1993, compared to 8 percent in FY 1970, and 5.4 percent in FY 1980.

Table I-2 also gauges federal R&D in relation to the gross domestic product (GDP). After dropping between FY 1970-1980 from 1.6 percent of GDP to 1.2 percent, federal R&D has received a fairly stable share of national income. What has changed over time has been the mix between defense and non-defense R&D, which these figures reflect.

Benchmark Changes

This report uses the GDP benchmark in keeping with current agency practice. Readers should be advised that the method used to calculate constant, inflation-adjusted dollars has changed this year in three ways. First, the Commerce Department has updated the base year to FY 1987 from FY 1982. Second, the deflators are based on the GDP, which analysts suggest is a better gauge of U.S. income than the gross national product (GNP). CBO notes that the shift should have little effect on policy and economic analyses. Finally, the constant dollar estimates in this report are no longer being computed using deflators tailored for defense R&D and non-defense R&D, because the Office of Management and Budget (OMB) no longer develops these disaggregated deflators.

By switching to the FY 1987 GDP benchmark, the AAAS report will be consistent with estimates being done by most federal agencies. However, readers should note that estimates of constant dollar changes, especially over long periods, will differ substantially from earlier AAAS R&D reports.

R&D in the FY 1993 Budget

Subsequent tables in Part I highlight key features of R&D in the President's budget for FY 1993 (Tables I-3 through I-7), special trends in research funding (Tables I-8 through I-12, discussed in Chapter 2), and industry patterns (Table I-13, discussed in Chapter 3). Statistics on agencies' R&D proposals are presented at the end of Part II. The first table in that section (Table II-1) shows the total R&D request for each agency, including the split between funds for the conduct of R&D and R&D facilities. Details on the R&D programs within the major agencies are provided in Tables II-2 through II-20. Analyses of the R&D proposals by agency and by discipline are presented in Parts II and III of this report, respectively.

Table I-3 shows the **split between defense and nondefense R&D** by the three major measures of funding activity: budget authority, obligations, and outlays. (For definitions of these transactions, see the general notes at the beginning of this report.) The President's $75.7 billion request for all R&D would provide $2.4 billion more than was appropriated for FY 1992, an average increase of 3.3 percent. Expressed in constant dollar terms, the value of the federal investment would be unchanged from last year.

Nearly 80 percent of the $2.4 billion gain would be devoted to nondefense R&D, bringing the civilian total to $32.5 billion (up 6.1 percent over FY 1992, or 2.7 percent in constant dollars). Because of the sheer size of the R&D effort in defense -- $43.3 billion in FY 1993 -- adding $545 million for this category represents only a 1.3 percent increase over current levels (down 2.0 percent in constant dollars). R&D outlays are now rising faster than either budget authority or obligations in both categories, because of the lag between commitments and expenditures, especially for defense.

Viewing **trends by major functional components**, Table I-4 suggests that general science, transportation, and space are among the President's top R&D priorities. The 17.6 percent jump in funding for general science activities reflects the ongoing effort to double funding for NSF research (up 21.5 percent under the request), and the cost of building the SSC (which drives DOE's general science budget up an average of 12.2 percent). NASA's push to resume work on the National Aerospace Plane and expand aerospace R&D explains much of the 17.3 percent growth in transportation R&D, but heightened interest in highway research at the Department of Transportation reinforces the trend. Among the projects supporting the 7.4 percent gain in space R&D are the Space Station, Earth Observing System, and New Launch System. The 4.1 percent increase for health research largely tracks the trend in NIH funding. Other areas would bear the brunt of the President's freeze on domestic discretionary appropriations, notably research on agriculture (down 6.4 percent) and natural resources and the environment (down 1.6 percent).

Putting these trends into historical context, Table I-4 shows the extent to which the government's R&D resources have shifted from nondefense to defense purposes over the last thirteen years. Despite the slowdown of recent years, defense R&D would remain dominant at 57 percent of the FY 1993 total, up from 47 percent in FY 1980. Adjusting for inflation, health research has moved ahead in funding as well as share, now claiming 14 percent of the total. Table I-4 suggests that most of the relative gain for defense R&D came at the expense of space and energy programs.

The Administration's budget offered an alternative perspective on research priorities, presenting funding for major initiatives being coordinated by FCCSET. These interagency cross-cuts focus attention on the government's leading R&D concerns, but do not necessarily represent new programs or funding. Four of the **FCCSET initiatives** directly involve R&D. Together they represent $8.0 billion of the R&D effort proposed for FY 1993 (up $845.3 million, or 11.8 percent).

Biotechnology research is the largest at $4.0 billion (up 7 percent), primarily reflecting the work on these issues at NIH, where 78 percent of this money is budgeted. Key sponsors of the government's $1.8 billion investment in Advanced Materials and Processing R&D (up 10 percent) include DOE, DOD, NSF, and NASA. NASA also accounts for 65 percent of the $1.4 billion allocated for global change research (up 24 percent), with NSF and DOE together contributing another 20 percent. Lead agencies for the $802.9 million effort on High Performance Computing and Communications (up 22.6 percent) are DOD, NSF, and DOE. While not generally classified as R&D, the fifth FCCSET initiative -- on Math and Science Education -- oversees the government's $2.1 billion effort to develop the human resources underlying the nation's research capability (up 7 percent).

Tables I-5 and I-6 display the R&D budget by **character of work**. Since FY 1980, basic and applied research have together accounted for slightly over a third of the government's R&D funding, but the emphasis has tilted from applied to basic research. The Administration's FY 1993 request continues this shift, proposing $14.3 billion for basic research (up 8.0 percent) and $13.4 billion for applied (up 4.8 percent). Most of the remaining two-thirds (or $45.1 billion) goes toward development, which in the coming year would remain roughly even after adjusting for inflation.

The $2.9 billion request for facilities (down 15.9 percent) reflects tight budgets, porkbarrel politics, and the new world order. For example, NASA eliminated funding for the Advanced Solid Rocket Motor program (ASRM) to stay within congressional guidelines for the agency. The Administration also discontinued over $100 million in funding for a long list of projects earmarked by Congress for FY 1992, mostly at USDA and NASA. DOE would delay construction of a New Production Reactor for tritium as the nation rethinks its nuclear weapons policies.

Table I-6 also illustrates how the character of work varies between the defense and nondefense categories. Over 90 percent of the government's basic research is funded by civilian agencies, and most of the growth proposed for basic research would occur there. The pattern is the same for applied research: nondefense agencies sponsor more than 70 percent and would gain virtually all of the money being added for it. Roles are reversed in development, where defense accounts for over 80 percent of the funding and most of the added money (but grows at a slower rate because of its relative size).

Finally, the R&D budgets proposed for selected agencies are summarized in Table I-7. Table II-1 provides this information for all agencies that sponsor R&D, including the split between funding for the conduct of R&D and R&D facilities. Key findings follow:

- Much of the decline in defense funding would result from cutbacks in DOE's atomic energy defense program, which would lose 10.6 percent (to $3.2 billion) as the department delays development of the New Production Reactor and various weapons projects.

- DOD's $40.1 billion R&D request sharply curtails funding for the Army (down 17 percent) while expanding work at the Navy (up 11 percent) and Air Force (up 5.8 percent). The modest 1.0 percent increase proposed for Defense Agencies' R&D belies a major realignment of these programs, in which SDI would garner $5.3 billion (up 29.1 percent) at the expense of most other activities, including the Defense Advanced Research Projects Agency (down 17.2 percent).

- Doubling the NSF budget by 1994 remains a top priority of the Bush Administration, as evidenced by the $2.5 billion requested for the agency's research effort (up 21.5 percent). Much of this increase would be devoted to expanding NSF's role in the FCCSET initiatives, and to social and environmental research.

- DOE's General Science appropriation would grow 12.2 percent to $1.6 billion, with almost the entire increase going for the SSC (up 35 percent to $638.1 million in FY 1993). Funding for DOE's Nuclear Physics and High Energy Physics programs would decline after adjusting for inflation. Most aspects of DOE's Basic Energy Sciences research (within the department's "Energy" budget) would register double-digit gains, but cutbacks in coal and nuclear pull the average increase down to 1.9 percent (to $3.3 billion).

- All of the growth in NASA's budget would support R&D. According to OMB's figures, funding for NASA's operations would fall 1.3 percent (to $5.7 billion) while research activities would gain 8.7 percent (to $9.3 billion). Favored projects include the Space Station, New Launch System, Earth Observing System, materials processing, civilian space technology, and National Aerospace Plane.

- NIH's $9.0 billion budget tends to overshadow other R&D activities at the Department of Health and Human Services (HHS) in both dollars and priority. The 5.1 percent increase in funding for NIH research would be spread relatively evenly among the institutes except for the Office of Director, where funding would surge 43.1 percent as it tackles issues related to women and minorities. Most R&D conducted by the Alcohol, Drug Abuse, and Mental Health Administration would fare as well as NIH, but many of HHS's other health and human services research programs would lose funds.

- The Administration advocates appropriating $255.2 million for R&D at the National Institute of Standards and Technology. This 28.6 percent increase would be used to replace obsolete equipment and facilities, and expand research on computer systems, manufacturing processes, materials, and advanced technology.

- The R&D budget at the Department of Education would jump 26.2 percent to $217.4 million in FY 1993. Almost all of the money would be added for Education Research and Statistics, which would in turn focus its research on at-risk students.

- Finally, several sponsors of R&D on natural resources would see funding decline, including the USDA, U.S. Geological Survey, Bureau of Mines, and National Oceanic and Atmospheric Administration. Congressional earmarks were a prime focus of the cutbacks. Pork-barrel projects also were dropped from the R&D request for the Environmental Protection Agency (EPA), but increases for multimedia research and air quality R&D enabled EPA to emerge with a 5.3 percent gain over FY 1992 levels.

Prospects for R&D in the FY 1993 Budget

Each year the scientific community takes stock of the government's commitment to R&D in both absolute and relative terms. In the political arena, however, the R&D budget is viewed primarily in a comparative context. Recent AAAS studies have shown that R&D ranks among the top priorities of the Congress and the Administration, as evidenced by the better-than-average increases in R&D appropriations.

The President would continue this favorable treatment, providing R&D a 3.3 percent increase within a budget that calls for flat or declining funding for other discretionary programs. The Administration would cut aid for housing, transportation, rural development, and other needs to pay for the increases proposed for R&D and other presidential priorities. In terms of appropriations, the President's budget would mean large increases for one of the thirteen subcommittees, and real, inflation-adjusted losses for all of the others. This is an unlikely scenario given past congressional efforts to spread the wealth and the pain.

Tradeoffs were also made among R&D activities. The clear winners were programs aligned with the FCCSET initiatives and large projects that have thus far withstood congressional scrutiny -- SDI, SSC, and the Space Station. Elsewhere, the R&D budget shows symptoms of fiscal distress. Funding for physics research at DOE would stagnate in real, inflation-adjusted terms without the pluses for the SSC. NIH anticipates fewer new research grants, because of the lack of significant real growth in funding. NASA scrapped the Advanced Solid Rocket Motor program and rescoped other R&D projects to stay within the parameters set by Congress. The Global Change program hopes that DOE will get $10 million for a remotely-piloted aircraft, because Congress zeroed-out this item in NASA's FY 1992 budget for lack of funds. EPA would expand its role in global warming research, but cut funding for research on ozone depletion. The list goes on.

Few are likely to agree with all of the tradeoffs made by the Administration. The challenge is to find alternatives -- either in new money or new choices. Congress could do both this year. Tapping the peace dividend would ease the unintended strain on domestic programs, which lawmakers are especially loathe to cut in an election year. Even with an infusion of money from defense, however, funds for domestic programs would remain tight. As a result, it is likely that Congress will reopen the debate about the SSC, Space Station, and other high profile R&D investments.

Recent trends suggest that Congress is unlikely to allocate more to R&D than proposed by the President, but may well alter priorities. If this holds true again, the focus of federal R&D -- but not the government's real level of support -- may change in the coming year.

Chapter 2

Special Analyses

American Association for the Advancement of Science

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This chapter provides brief overviews of several important areas of R&D trends. These include federal funding of basic research, federal support for R&D at colleges and universities, and a broadbrush picture of the major national performers and funders of R&D. Tables supporting this discussion are at the end of Part I.

Highlights

- Basic research support is expected to increase by just over $1 billion, to $14.3 billion in FY 1993 -- an increase of 8 percent. This rate of increase is more than double that of federal R&D as a whole (3.3 percent).

- Basic research has been a favored area within overall federal R&D support over the past decade or more. By any measure, basic research has grown faster than R&D as a whole, and has steadily increased its proportion of an increasing federal R&D support program. That proportion for FY 1993 would be nearly 19 percent of total federal R&D support.

- Basic research support is dominated by nondefense work, which accounts for over 91 percent. Defense basic research for FY 1993 continues its recent pattern of very slow or no growth, while nondefense basic research support would increase by almost 9 percent to $13.1 billion.

- NSF and NASA stand out among the larger agencies in anticipating significant increases in basic research support. NIH, the largest federal supporter of basic research, expects a modest increase, and DOD and USDA are slated for minimal increases. Several smaller agencies (for example, Interior, Education, and AID) expect significant decreases.

- Support for research at colleges and universities is expected to increase by nearly $600 million (over 5 percent), to about $11.5 billion in FY 1993.

- The federal government's role in the overall national R&D picture, while increasing in an absolute fashion, has been eroding slightly (relative to other sectors) as both a source of R&D funds and as a performer of R&D. Industry continues its dominant role, and colleges and universities have increased their presence as both sources and performers of R&D.

Basic Research

The Administration gave strong support again this year, in the language of the budget documents, to basic research and the need for vigorous investment in it by the federal government. Chapter 6 of the Budget Book, "Enhancing Research and Development and Expanding the Human Frontier," contains among other things an overview of the role of basic research in the national agenda, a discussion of economic benefits from it, documentation of the U.S.'s leading role in generating knowledge through research, mention of the key role of individual investigators (particularly at academic institutions), and a statement of the Administration's commitment to strengthening basic research -- all prior to going through the specific items designed to illustrate this commitment.

Federal support for basic research by agency is shown in Table I-8, with FY 1980 figures as a comparison point. It is important to note that the figures for basic research shown in this table are not actually direct budget proposals, but rather are *estimates* of basic research funding derived from proposed budget data. Agencies present their requests in programatic terms, and then estimate the amounts that would be spent on different types of R&D based on those requests. Further, interpretations of the definition of basic research are not uniform across agencies, and each agency makes its own distinctions as to type of R&D and estimated spending for each. Consequently, the data reported here are imprecise although generally suggestive in the aggregate.

In the budget proposed for FY 1993, support for basic research would increase from $13.3 billion to roughly $14.3 billion, an increase of slightly over $1 billion, or 8 percent in current dollars and 4.5 percent in constant FY 1987 dollars. These rates of increase are higher than those for R&D overall (3.3 percent in current dollars and zero increase in constant dollars).

Basic research has grown in both absolute and relative terms over the past decade or so. The FY 1993 estimates are about 72 percent higher than in FY 1980 after correcting for inflation -- an average *real* growth rate of about 4.6 percent per year compounded. (Against this standard, the proposed increase in basic research estimated for FY 1993 is about the same as the average rate of increase over the past dozen years.) By comparison, the growth of total R&D over the same period since FY 1980 has been 29.7 percent, or an average annual real growth rate of 2.2 percent per year compounded (see Table I-4 or I-5).

In addition, basic research has generally grown over the years in its proportion of total federal R&D support, going from 10.7 percent in FY 1967 (touted as the "golden age" of R&D funding) to 14.2 percent in FY 1980, and settling into the 18 percent range in the past few years. FY 1993's estimates for basic research represent nearly 19 percent of total federal R&D support (see Table I-5).

Turning to comparisons of defense and nondefense support, in the past few years a bit over 90 percent of federally supported basic research has been nondefense, as shown in Table I-6. (In this table, defense includes, in addition to the Department of Defense (DOD), the Department of Energy (DOE) military-related programs.) For FY 1993 federally funded basic research would be 91.4 percent nondefense. Defense basic research for FY 1993 (of which 97.4 percent is DOD) continues its recent pattern of very slow or no growth. Figures in Table I-6 show only 2 percent growth in current dollars, and a slight decline once inflation is taken into account. By contrast, nondefense basic research in FY 1993 would increase by 8.6 percent over FY 1992 to $13.1 billion. Over the past two years (since FY 1991), nondefense basic research funding has increased $1.9 billion, or 17 percent in current dollars.

Turning to the agencies (Table I-8), the overall pattern is mixed, with the larger supporters of basic research generally getting larger percentage increases than the smaller agencies, although some are less than the rate of inflation. NIH continues its long-standing role as the largest single federal supporter of basic research. Its estimated total for FY 1993, $5.3 billion, would represent 37.2 percent of all federally supported basic research, roughly the same proportion as the past three years. NIH's basic research in FY 1993 is expected to increase 6.1 percent in current dollars (2.7 percent in constant dollars), slightly less than the overall rate of increase for basic research.

Among the larger R&D agencies receiving significant increases in basic research are the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF). NSF would receive a $382 million increase (nearly 21 percent) in basic research funds. NASA's increase would be $207 million, or 11 percent in current dollars. (NIH, NSF, and NASA together account for $898 million or 85 percent of the total expected increase in federally supported basic research.) However, since NSF and NASA are handled within the same appropriations subcommittees, it is unlikely that both will sustain the proposed increases in the course of running the congressional budgetary gauntlet. Mid-size to smaller R&D agencies anticipating noteworthy increases in basic research funds include the Smithsonian Institution (almost 17 percent), the Commerce Department (12 percent), and the Environmental Protection Agency (nearly 13 percent).

Agencies slated for sizable decreases in their basic research funds include the Interior Department (down over 11 percent in current dollars), the Department of Education (down 14 percent), and the Agency for International Development (down more than 11 percent).

The other significant players in the federal basic research support game are the Departments of Energy and Agriculture. DOE would receive an increase of $78 million, or 4.4 percent in current dollars and just 1 percent in constant dollars. DOE is proposing an increase of $24 million for basic research components of the Superconducting Super Collider (SSC), going from $93 million to $117 million, an increase of 26 percent. By contrast, all other basic research within DOE -- comprising $1.7 billion -- would increase by about 3 percent ($54 million), barely staying even with inflation.

The USDA's basic research would increase by about $28 million (4.6 percent), boosted by an estimated 53 percent increase in the National Research Initiative to $105 million. However, apart from the $36 million increase in the NRI, the rest of USDA basic research would decrease by a total of $8 million, or about 1.5 percent in current dollars and nearly 5 percent after inflation.

Details regarding the specific effects of these trends within each of the agencies can be found in the relevant chapters in Parts II and III of this book.

Colleges and Universities

Federal support for R&D in colleges and universities has become more visible as a public policy issue, as scientists have become more vocal about the squeeze they are experiencing in trying to secure funding for their research. Data on expected federal support for R&D in colleges and universities are shown in Table I-9. We should emphasize -- as we did for basic research above -- that these data do not represent direct programatic decisions, but are after-the-fact estimates of how much funding is likely to go to colleges and universities under program levels contained in the budget request.

Overall, the total of federal R&D support to colleges and universities is expected to increase somewhat by 5.4 percent ($592 million) to about $11.5 billion. When this is converted to constant dollars, the rate of increase falls to 2 percent. Real growth in the two years between FY 1991 and FY 1993 would be 4.6 percent under the proposed budget.

Federal agencies fall into three fairly distinct tiers, in terms of their amount of support for R&D in colleges and universities. In the top tier are NIH (with estimated support of $5.2 billion in FY 1993), NSF ($1.9 billion), and DOD ($1.4 billion). In the second tier are NASA (estimated at $675 million), DOE ($591 million), and USDA ($417 million). The rest of the agencies fall into the third tier, with the largest being the Department of Education, estimated to provide $125 million in support for R&D at colleges and universities. Broken out this way, the first tier -- NIH, NSF, and DOE -- collectively accounts for virtually all of the growth in support for R&D going to colleges and universities ($615 million), with the other two tiers each having aggregate declines (second tier: an aggregate decrease of $3 million; third tier: an aggregate decrease of $20 million). Of course, there are variations among agencies within each of the tiers, and we turn to those next.

Within the top tier, NSF would receive the largest growth of such funds under the proposed budget, an increase of $320 million or 20 percent in current dollars (16 percent in constant dollars). NIH and its parent department, Health and Human Services, would receive a more modest increase of about 5 percent. However, NIH would still furnish 45 percent of all federal funds going for R&D in colleges and universities. DOD's support in this area would increase very slightly in current dollars ($28 million, or 2 percent), but would be a slight decrease in constant dollars (1.3 percent).

Within the second tier of agencies, NASA's support for R&D at colleges and universities would increase by $43 million or almost 7 percent in current dollars (about 3 percent in constant dollars). DOE's support is expected to decline by 6 percent in constant dollars ($38 million) and by 9 percent in constant dollars. The USDA's support in this area would also fall slightly (by $9 million, or 2 percent in current dollars and 5 percent in constant dollars).

Below these two tiers are several other agencies which present a mixed picture in terms of R&D support in colleges and universities. Agencies anticipating increases in this area include Education (nearly 16 percent), Transportion (almost 10 percent), and EPA (just over 6 percent). Agencies slated for decreases include Interior (over 30 percent) and Commerce (25 percent).

National Patterns of R&D

Table I-10 shows the national patterns of R&D spending estimated by NSF for 1991, arraying sources of funds against R&D performers. (In past years, NSF has had projections of this kind for the calendar year just entered. But because of organizational changes at NSF, these data for 1992 are not yet available.) These estimates show that total national spending for R&D in 1991 was $151.6 billion, a very slight decrease in constant dollars (0.3 percent) over the two-year period 1989-1991.

These data show federal spending accounting for $66 billion, or 43.5 percent, of national R&D spending. Table I-11 shows that this share has fallen from 57 percent in 1970, with the largest part of this relative decline occurring in the 1970s. Industry in 1991 spent about $78 billion on R&D, or 51.5 percent of national totals. This share is up somewhat from 49.4 percent in 1980, but up markedly from 40 percent in 1970. Again, the biggest relative shift came in the 1970s. In that decade, federal spending for R&D doubled in current dollars, but industry spending tripled.

Funding of R&D by (a) colleges and universities and (b) nonprofit organizations is still relatively small (3.3 percent and 1.7 percent of total national R&D spending, respectively). However, these were the fastest-growing segments over the past two years, with each showing about 15-16 percent real growth in this period. Colleges and universities in particular have increased their R&D support, both relatively and absolutely (see Table I-11). Since 1970 they have more than tripled their R&D support in *real* terms, and have gone from providing 1.8 percent of the national R&D support to 3.3 percent.

Among performers of the nation's R&D (see Table I-12), the primary performer continues to be industry, which performs almost all (97.6 percent) of the R&D that it supports, plus 49 percent of all federally supported R&D. Its total of R&D performance is over $108 billion, or 71.5 percent of total national R&D. This share has risen slightly from 69.1 percent in 1970, but has changed hardly at all since 1980. Colleges and universities performed $17.2 billion of R&D in 1991, which represents 11.3 percent of the national total. This sector, too, has increased its share over the past two decades, rising from 8.9 percent in 1970 and 9.7 percent in 1980. The sector that has declined, relatively speaking, in volume of R&D performed over the past two decades is the federal government. Federal support for its own R&D operations has increased, to be sure, even in real terms, but its proportion of the national R&D effort has fallen from almost 16 percent in 1970 to about 11 percent in 1991.

Finally, a breakdown of the sources of R&D support for college and university performers (Table I-10) shows that 56 percent of funds come from the federal government, with another 29 percent supported by colleges and universities themselves. Industrial support for R&D performed by colleges and universities -- the subject of much attention for over a decade -- continues to grow at a significant pace, almost 17 percent in constant dollars over the past two years. It was estimated at $1.25 billion in 1991. However, it is still the smallest source of R&D funds for colleges and universities, even trailing support from nonprofit institutions. This $1.25 billion figure represents 1.6 percent of all R&D supported by industry.

Chapter 3

R&D in Industry

Industrial Research Institute

Charles F. Larson

Introduction

This chapter will briefly outline forecasts for industrial R&D spending in the United States during calendar year 1992, will describe the growing trend toward moving a higher percentage of this R&D effort offshore, and will summarize results of the Industrial Research Institute's (IRI) annual R&D trends forecast.

Industrial R&D Spending

Industrial support for R&D in the United States will reach an all-time high, in current dollars, during 1992. Battelle forecasts that this spending will be $80.5 billion, up from an estimated $78.0 billion during 1991. In constant dollars, however, the $80.5 billion is only 6.5 percent higher than it was five years ago, meaning that real growth has been less than 1.5 percent per year in this period.

Including government funds allocated to industry for R&D, Battelle estimates that industrial R&D will total $111.5 billion for 1992, an increase of only 2.8 percent from the $108.5 billion estimated for 1991. Thus, in constant dollars, both industry funding and industry performance of R&D may decline slightly this year.

Industry performs over 70 percent of all R&D carried out in the United States. A major portion of its R&D effort, around 73 percent, is spent on development, while 22 percent is allocated for applied research, and less than 5 percent is spent on directed basic research. These proportions have been fairly stable for some time.

R&D spending by industry in Europe and Canada has also slowed in recent years, and in some cases may also be declining during 1992. In contrast, Japanese industrial R&D spending is continuing to grow, in real terms, at a rate of 10 percent or more. The February 17, 1992 issue of Business Week indicated that private-sector research spending in Japan came close to that of the United States in 1990. The data on which this projection was based came from the September 27, 1991 Report of the Japan Economic Institute, which converted Japanese R&D spending directly from yen to dollars. New Technology Week reported February 24, 1992 that the American Embassy in Tokyo had recently indicated (also using a direct yen-to-dollar conversion) that industry spending on R&D in Japan was well ahead of that in the United States, at $90 billion for Japan's F.Y. 1990. However, a direct conversion of yen-to-dollar R&D spending may be misleading. For example, the National Science Foundation calculates foreign R&D spending figures on the basis of Purchasing Power Parity (PPP) tables prepared by the Bureau of Labor Statistics, and reports that Japanese industrial R&D spending was only 58 percent that of the United States in 1989.

Regardless of which conversion factor one uses, the current difference in the rate of growth between industrial R&D spending in Japan and the United States could have significant long-term implications by the year 2000. There is no doubt that Japanese industry is planning to be an even more formidable global economic competitor in the next century through strong current investments in new industrial science and technology.

Industrial R&D Spending Abroad by U.S. Companies

Although industrial companies in the United States have not, in aggregrate, been significantly increasing R&D spending in this country, they have been expanding R&D activities and budgets in other countries. A 1991 survey of member companies of the Industrial Research Institute showed that significant research facilities were being operated in over 34 foreign countries. Europe was still the most prominent location, with some 62 percent of the total number of laboratories reported. Japan was next, with 14 percent. The objective of this activity is not to save money, because in many cases industrial R&D abroad is more expensive and less productive than it is in the United States. The purpose is to develop technology to address opportunities in local markets around the globe and to protect existing competitive positions.

The National Science Board's Science & Engineering Indicators for 1991 reported that company-financed R&D performed outside the United States rose from $3.65 billion in 1985 to $6.52 billion in 1989, an annual growth rate of 20 percent. It is estimated that this rate has been even higher during the past three years. However, these yearly totals do not equal the R&D spending in the United States by companies in other countries. Foreign R&D expenditures in the United States were $5.24 billion in 1985, and rose to $9.26 billion in 1989, a growth rate nearly the same as for U.S.-company R&D spending outside the country. This rate has no doubt also increased since 1989.

Globalization of Industrial R&D

A recent pilot survey of selected senior research directors in IRI member companies illustrated some of the reasons behind the globalization of industrial R&D.

Everyone responding to the survey indicated that their company has an active commitment to find and utilize technology outside of their own laboratories. Seventeen percent of the companies considered this effort a high priority, while 72 percent ranked it of medium priority, and 11 percent gave it low priority. More than half of the companies considered the task part of the job responsibility of specific individuals or part of everyone's job, and had done so for more than five years. Forty percent noted they had been carrying on the effort for more than 10 years.

Geographic coverage of their technology search has been global for 76 percent of the respondents. While only one of them did not consider the effort to be successful, all respondents acknowledged at least some difficulties in the process. The most frequently mentioned problems associated with finding and utilizing technology from outside their own laboratories were in transferring it to within the company, or internalizing the technology, and assessing the value of externally accessed technology. Both of these problems are influenced by the "NIH" factor ("not invented here") and R&D planning.

As described above, the trend toward globalizing R&D and technology acquisition is growing, making intellectual-property protection a critical issue that has profound implications for both the sellers and buyers of technology.

R&D Projections for 1992

In August 1991, IRI's eighth annual survey of industrial R&D trends* was sent to 263 member companies, with 132 replies (a 50 percent response). Respondents were asked to estimate relative changes in levels between 1991 and 1992 in the following categories: Expenditures, Effort Allocation, Personnel Trends, Other Trends.

As in previous years, a scale of 1-5 was used:

1 = "significantly less" (-5 percent or less)
2 = "slightly less" (0 to -5 percent)
3 = "approximately the same" (1 to 5 percent more)
4 = "slightly more" (6 to 10 percent)
5 = "significantly more" (more than 10 percent)

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*"Industrial Research Institute's Annual R&D Trends Survey," RESEARCH TECHNOLOGY MANAGEMENT, January-February 1992, pp. 14-16.

Highlights of the survey follow:

- R&D executives appeared to be cautious about 1992 in their estimates of funding and manpower change. This was in marked contrast to the general optimism noted in all seven previous IRI surveys.
- Only 20 percent expected to increase their total R&D expenditure from the 1991 level by at least 6 percent.
- Seventy-eight percent did not expect any significant increase in capital expenditure for their R&D operations.
- Sixty-seven percent expected their R&D professional manpower level to remain virtually unchanged or to drop from the 1991 level.
- Only 12 percent planned to increase hiring of new graduates by 6 percent or more.

Significant Changes from 1991 to 1992

- For the 132 respondents taken as a group, R&D as percent of sales was expected to drop slightly from 3.4 percent in 1991 to 3.2 percent in 1992. The combined R&D expenditure of these 132 companies was estimated to be approximately $35 billion in 1991. None of the reporting industry sectors projected increases in the R&D-to-sales ratio.
- Capital expenditure for R&D (as percent of R&D budget) was also likely to drop slightly from 13.7 percent to 13.4 percent. Only two industry sectors--Paper and Allied Products, and fabricated Metal Products--expected small increases.
- The average operational cost per R&D professional for the company's largest U.S. laboratory was

expected to increase slightly, from $195,000 per year to $204,000 per year.

- On allocation of R&D efforts, the responses indicated that:

  Greater expenditure was expected on (i) support of existing businesses; (ii) projects targeted at new businesses; (iii) technical service efforts for outside customers; and (iv) R&D efforts to respond to regulatory requirements.

  Expenditure on directed basic research was expected to decrease.

  Grants, contracts, etc., for university R&D were also expected to drop.

- On other matters such as top management attention, external interactions, etc., the responses indicated that:

  Top management was expected to pay greater attention to development as well as research activities.

  Participation in strategic alliances and licensing of technology would intensify significantly.

  While contacts with federal laboratories would increase somewhat, a large fraction of the respondents either did not believe contacts with federal laboratories and R&D funding through government contracts to be relevant, or they did not have any data on such matters.

  Only 16 percent of the respondents anticipated overhead costs to rise by 6 percent or more.

Significant Multi-Year Trends

The nature of the survey precludes a direct comparison with the results from a previous year's survey, especially on quantitative data such as R&D as percent of sales for specific industry sectors. Nevertheless, the surveys are quite useful as indicators of multi-year trends, if any, on many of the non-quantitative matters of interest to the R&D management community.

The 1991 survey results reaffirm several trends noted in the last few IRI surveys:

- Increasing focus on (i) supporting existing businesses; (ii) R&D targeted at new business projects; and (iii) technical service for external customers.
- Increasing emphasis on (i) R&D efforts to respond to legislation, standards and other governmental rules; and (ii) external interactions, especially strategic alliances and technology licensing.
- Increasing attention from company top management to R&D activities.
- Decreasing participation in consortia for precompetitive university research, paralleling the declining trend in basic research support.

Numerical results of the 1992 trends forecast are shown in Tables 1 and 2.

Overall, industrial R&D in the U.S. will slow down in 1992. As a result, some of the items on the agenda of R&D directors are undergoing natural evolution, as well as increased scrutiny. While there is growing recognition that technology is critical to maintaining competitive advantage, this need is being addressed by greater focus on core technologies rather than increased R&D budgets.

Chapter 4

Science, Mathematics, and Technology Education and Human Resources in the FY 1993 Budget

American Association for the Advancement of Science

Janice Merz, Shirley M. Malcom

Highlights

- Overall federal funding request for precollege SMT education in FY 1993 is more than $768 million, an 18 percent increase over the FY 1992 enacted amount. (This does not include support for Chapter 1 and Chapter 2 block grants that support science, mathematics, and technology (SMT) education goals or other programs not included in the FCCSET analysis.)

- Almost $481 million is being requested for undergraduate SMT education, an 8 percent increase from FY 1992 enacted levels.

- The $750.2 million requested for graduate SMT education represents a 2 percent decrease in the level of support for these programs over the FY 1992 enacted level of support.

- In a separate budget category for FY 1993, the President's request includes $93 million for public science literacy programs. FY 1992 support for these programs was almost $91 million.

Introduction

The Federal Coordinating Council for Science Engineering, and Technology (FCCSET) Committee on Education and Human Resources (CEHR) continues to play a central role in the coordination of federal agency education activities. CEHR establishes programmatic and budgetary priorities for the continuation of existing programs and the initiation of new ones. The FCCSET analysis, *By the Year 2000: First in the World*, serves as the primary basis for budget information in this section.

The President's FY 1993 budget requests nearly $2.1 billion in support of mathematics, science, engineering, and technology education, and public science literacy, an increase of $138 million or 7 percent over the FY 1992 enacted levels for these programs. The FY 1993 request represents a nearly 22 percent increase in funding over the FY 1991 enacted levels. Precollege programs have received the greatest increase in FY 1991-93, with nearly 50 percent of the budget growth between these periods.

The FCCSET-CEHR analysis is restricted to those programs "legislated by Congress for science, mathematics, engineering and technology education or expressly managed by agencies as an education-related activity." Consequently, this analysis likely underestimates the level of federal resources affecting science, mathematics, and technology (SMT) education, since programs in education -- such as the mathematics and science support provided through Chapter 1 and magnet schools -- are not counted in the FCCSET-CEHR numbers.

The budget presentation is organized around the theme of providing support for the President's America 2000 agenda, cited as a strategy for achieving the National Education Goals in SMT education. The emphasis here has clearly been on improving the quality of K-12 SMT education, and the shift in budget allocations toward precollege demonstrates this point. In FY 1992 the budget for science, mathematics, and engineering (SME) education which was requested by the Administration would have provided 34 percent for precollege, 24 percent for undergraduate, and 41 percent for graduate level programs. The FY 1992 budget which was enacted (and rebaselined) provided 33 percent, 22 percent, 39 percent, and 4 percent, respectively to K-12, undergraduate, graduate, and public science literacy programs. For FY 1993 the SMT education request is 37 percent precollege, 23 percent undergraduate, 36 percent graduate, and 4 percent public science literacy programs.

Precollege

The National Science Foundation (NSF) and U.S. Department of Education (ED) programs represent 85 percent of the total allocation for precollege SMT education. Activity at the precollege level is centered around four program elements:

- teacher preparation and enhancement
- curriculum reform
- organizational reform
- student incentives and opportunities

Through its Eisenhower State Grants program, ED provides nearly two-thirds of the support for teacher enhancement. The FY 1993 request of $248 million will support state formula grants for mathematics and science initiatives in elementary and secondary schools. Each state is required to set aside 25 percent of its allocation for teacher training programs conducted by institutions of higher education. In particular ED is proposing to require that such funding be used to support more intensive training efforts for teachers of at least 20 days duration. For the National Eisenhower program $56 million is being requested, an increase of $40 million (250 percent) over the FY 1992 enacted level. This includes $36 million for the new FCCSET initiative to support model projects that would employ experienced secondary mathematics and science teachers to train elementary and middle school teachers. Among FCCSET-CEHR agencies, NSF has the lead in both curriculum and organizational reform (74 percent and 98 percent, respectively) through its support for curriculum materials, large-scale reform projects, and systemic initiatives. Sixty percent of the support for student incentive programs is spread among eight agencies, including Health and Human Services (HHS), Department of Energy (DOE), NASA, Department of Defense (DOE) and the Department of Interior (DOI).

Undergraduate Education

For FY 1993 $480.77 million is requested for undergraduate education; an increase of 8 percent over FY 1992 enacted levels and 16 percent over FY 1991. In the FY 1993 request, funding for financial support and research opportunities for students comprises almost 40 percent of the total request. DOD and NSF represent nearly two-thirds of all funding at the undergraduate level. DOD funding primarily provides direct student support through the Reserve Officer Training Corps (ROTC); NSF provides the majority of support for curriculum, faculty development, and operational reform.

Graduate Education

Over $750 million is requested in FY 1993 for support of graduate education programs. This represents a $19 million, or 2 percent, decrease from FY 1992 levels due to an add-on in the FY 1992 budget for pre- and postdoctoral traineeships. Nearly 75 percent of these funds support activities at HHS and DOD. HHS receives 49 percent, $364 million of the total, primarily to support pre- and postdoctoral traineeships. Of the $234 million requested by DOD for FY 1993, $203.7 million (86 percent) will support graduate education at the military-operated graduate schools. The remaining funds support predoctoral fellowships, predoctoral traineeships, and postdoctoral fellowships at other institutions. Other agencies, including NSF, USDA, NASA, DOC, DOE, DOI, SI, and EPA, also allocated funds for direct support of graduate education programs. It should be noted that the largest source of graduate student support is included in research grants to faculty and is not shown in the FCCSET analysis. For example, the NSF FY 1993 request alone for grants to support faculty research contains an estimated $96.5 million for postdoctoral support and $283 million for graduate student support.

Public Science Literacy

The $93 million request for FY 1993 represents 4 percent of the FCCSET-CEHR budget. Public science literacy programs are contained in a separate budget category for the first time in the FY 1993 request. The current federal strategy for public science literacy programs includes public and community-linked program, media dissemination, programs for decision-makers, and public information campaigns. In FY 1993, 64 percent of the FCCSET public science literacy budget supports public and community-linked programs and media dissemination. Almost 80 percent of the funding is allocated to DOI and NSF. The DOI National Park and Refuge programs receive more than half of the designated support for public and community-linked programs. Media programs supported by the NSF account for nearly 70 percent of the media dissemination funds.

National Science Foundation (NSF)

In the FY 1993 FCCEST analysis, the National Science Foundation request is $537.2 million. Of this total, $439.1 million is for the NSF Directorate for Education and Human Resources (EHR) FCCEST programs. Not included in the FCCSET analysis are human resources programs for women faculty and minority institution research improvement. The FY 1992 current plan for these programs is $46.6 million. The FY 1993 request is $50.1 million, a 7 percent increase from FY 1992 enacted levels. The total EHR FY 1993 request is $479.5 million. This represents a 3.1 percent increase over the FY 1992 current plan of $465 million. The FY 1992 current plan of $465 million for EHR programs is $75 million above the FY 1992 request, an increase of 19.2 percent. Increases specified by Congress included funding for teacher enhancement and informal science education, systemic reform, and graduate education and research development. The emphasis being placed on systemic reform activities is evidenced by the fact that the FY 1992 current plan exceeds the FY 1992 request by $11 million, a 32.8 percent increase. The FCCSET analysis includes the EHR allocation and $58 million from the research directorates, mostly for undergraduate and graduate level activities. Approximately 50 percent of the NSF education budget is aimed at the precollege level; the remaining funds are allocated to undergraduate student support and institutional support.

Department of Education

Department of Education requests $29.1 billion for FY 1992, with $392.5 million in FCCSET-CEHR programs. This is an increase of $98.7 million, or 33 percent, over the FY 1992 enacted levels for FCCSET-CEHR programs. As discussed earlier, the Eisenhower programs -- including state grants, national grants, and the regional consortia -- receive the bulk of the FCCSET-CEHR funds. Other programs of importance include the National Science Scholars program, which works to improve science and mathematics achievement by providing scholarships to graduating high school students who have excelled in SME education. In FY 1992 this program was funded at $4.5 million. For FY 1993 $15 million is requested, an increase of $10.5 million. The Eisenhower Mathematics and Science Education Regional Consortia, located in 10 regions throughout the country, disseminate information on exemplary science and mathematics instructional materials and provide technical assistance in the use of improved teaching methods and assessment tools. For FY 1993 $12 million is requested for continued support of this activity.

The Minority Science Improvement program provides financial assistance to improve science and engineering programs at postsecondary institutions with predominantly minority enrollments. The FY 1993 request of $6 million equals the FY 1992 appropriation.

An increase of $34.9 million is included for the National

Assessment of Educational Progress (NAEP) for analyzing and reporting the results of the 1992 assessments, which include the State-representative assessment in mathematics, and for developing and planning for the 1994 assessments. ED plans call for national assessments at grades four, eight, and twelve in reading, mathematics, science, history, and geography in 1994. The total request for assessment in FY 1993 is $64.8 million, an increase of $34.90 million over FY 1992 anticipated levels. This reflects the heavy emphasis being placed on assessment by ED. NAEP is not included in the FCCSET-CEHR analysis.

Department of Agriculture (USDA)

Of the $22.65 million requested for FY 1993, most supports programs at the undergraduate and graduate levels. Evidence of USDA's commitment to advance minority participation is the continued increase in funding for the 1890 Institutions and Research Capacity Building Grants Program for programs in food and agricultural sciences. This program supports efforts at Historically Black Colleges and Universities enacted by the Morrill Act of 1890 and Tuskegee University. In addition, USDA has expanded its Graduate Fellowship Grants Program to reduce shortages in scientific expertise.

Department of Commerce (DOC)

All of the funds requested by DOC for FY 1993, $3.68 million, are to support fellows participating in the National Institute of Standards and Technology/National Research Council Postdoctoral Research Associateships Program.

Department of Defense (DOD)

DOD programs in education primarily provide financial support for graduate and postdoctoral grant programs. Of the nearly $416 million requested for FY 1993, $234.8 million is for graduate programs and $176.2 is for undergraduate programs. The undergraduate support is primarily for science, mathematics, and engineering majors participating in Reserve Officers Training Corps (ROTC).

Department of Energy (DOE)

In FY 1993 DOE will lead an interagency teacher enhancement initiative that utilizes Federal laboratories working in collaboration with universities, state and local educational agencies, businesses and industry. DOE is requesting $113.21 million for FY 1993: $32.39 for FCCSET precollege programs, $56.87 million for undergraduate programs, $19.62 for graduate support, and $4.34 for science literacy public programs. DOE intends to expand alliances between DOE laboratories/facilities and minority colleges and universities to encourage students to pursue careers in environmental sciences and waste management.

Department of Health and Human Services (HHS)

In FY 1993 HHS, as part of its new Science Teaching Enhancement Program, will implement a Pre-Service Teacher Training Program targeted at future K-12 teachers. Of the $416.45 million requested for FCCSET programs in FY 1993, $364.01 (87 percent) supports graduate training and career enhancement in biomedical and health-related fields.

Department of Interior (DOI)

More than 50 percent, $43.34 million, of the FY 1993 DOI request is for public science literacy programs organized primarily through the National Park Service. In addition, $25.3 million, 28 percent, is for precollege programs, including the U.S. Geological Survey (USGS) Joint Education Initiative (JEDI). The JEDI initiative involves developing precollege educational materials that incorporate actual databases and software used by professional earth scientists. Not included are funds distributed through the Bureau of Indian Affairs (BIA) for SMT education programs provided through the BIA schools.

Environmental Protection Agency (EPA)

More than 80 percent of the $9.8 million requested for EPA-CEHR FCCSET programs is for precollege programs. In FY 1993, EPA will provide $4.1 million in grants to postsecondary institutions to operate an environmental training and education program as well as grants to support local, state, and nonprofit environmental education.

National Aeronautics and Space Administration (NASA)

In FY 1993, the NASA request for FCCSET-CEHR programs is $82.27 million. NASA efforts are focussed on undergraduate and graduate programs: $32.4 million for undergraduate programs and $33.2 for graduate programs. In FY 1993, NASA will complete the implementation of the National Space Grant College and fellowship

Program, 50 state consortia of colleges, universities, nonprofit organizations, industry and state and local governments. Included in this program is a major component emphasizing precollege education, emphasizing CEHR priorities.

Smithsonian Institution (SI)

In FY 1993 the SI will expand its precollege level programs in addition to continuing to strengthen and expand its public science literacy activities. The SI FCCEST-CEHR request for FY 1993 is $10.04 million. Of this, $8.91 million, 88 percent, is earmarked for public science literacy programs focussing on public or community-linked programs and media dissemination. The precollege budget is $630,000 and will support such activities as the National Resource Center Leadership Institutes, the Smithsonian Astrophysical Observatory Project Start, and the National Air and Space Museum Education Outreach activities.

Conclusion

The federal government provides a small and decreasing proportion of support for K-12 education in the United States. With only 6 percent of the investment coming from federal sources, only through heavy leveraging of funds can there be any hope of affecting the quality of education in science, mathematics, and technology that children receive. High leverage programs include those which have the potential to affect the way large portions of the other 95 percent of funds is used. The statewide systems initiatives (SSI) program is one area of high leverage, as is funding invested to support new frameworks and new assessment tied to those frameworks. Heavy investment is also being made in teachers, particularly in providing more intensive training opportunities for more teachers via university and peer-based models. Coordination across agencies holds great promise, such as the memorandum of understanding which allows alignment of SSI and Eisenhower program funds.

The opportunities within the FCCSET-CEHR coordinating function are vast and as yet not fully explored. Fully exploiting the possibilities may mean broadening rather than narrowing, however, what is brought to the table. The Category I definitions that comprise the FCCSET analysis lead to the inclusion of programs with limited general access, while many programs that are omitted by definition are large targets of opportunity (e.g., Headstart and the large Chapter programs). Still to be developed are programs that affect organizational levels between that of states and individual classrooms. The move toward site-based decision making presents both large opportunities and large challenges to federal leverage seekers. And urban centers with school populations larger that those of many states with fewer of the challenges of geographic spread remain targets of opportunity.

While NSF leadership has suggested that time is needed to stabilize the EHR infrastructure to accommodate the rapid growth in the size of its budget, congressional leaders may wonder about the signal sent with a requested 3 percent increase in education and 17 percent increase for research and related.

Only time will tell whether the FCCSET-CEHR process will lead to greater program coordination and leveraging. Always risky in coordinating is loss of program identity and thus program justification. Realizing the FCCSET promise will depend on who steps into the leadership role, the ability to walk the tightrope between program coordination and program absorption and opening the discussion with agency and congressional leaders about putting more areas for collaboration on the table.

FY 1991—1993 Growth by Education Level
(In millions) (FCCSET-CEHR analysis)

	FY 1991	FY 1992	FY 1993	Increase FY 91–93	%Increase FY 91–93
Grand Totals	**$1712.70**	**$1954.74**	**$2092.23**	**$379.53**	**19%**
Precollege	514.65	650.71	767.95	253.30	49%
Undergraduate	413.90	444.25	480.77	66.87	16%
Graduate	784.15	768.88	750.20	-33.95	-4%
Science Literacy	N/A	90.89	93.32		

FY 1991—1993 Growth by Agency
(In millions) (FCCSET-CEHR analysis)

	FY 1991	FY 1992	FY 1993	Increase FY 91–93	%Increase FY 91–93
Total Request	**$1715.70**	**$1954.74**	**$2092.23**	**$376.53**	**21%**
USDA	19.95	20.26	22.65	2.70	13%
DOC (1)	7.26	3.51	3.68	-3.58	-49%
DOD	416.04	415.97	415.97	-0.07	0%
ED	235.00	293.83	392.53	157.53	67%
DOE	64.14	108.56	113.21	49.07	76%
DHHS	486.33	411.94	416.45	-69.88	-14%
DOI	40.58	82.73	88.43	47.85	117%
SI	N/A	9.96	10.04	N/A	N/A
NSF	371.66	521.80	537.20	165.54	44%
NASA	68.15	77.79	82.27	14.12	20%
EPA	6.59	8.30	9.80	3.21	48%

(1) All years contain core NOAA and NIST postdoctoral program funding. FY 1991 figures also contain miscellaneous discretionary funding which may become available in FY 1992.

FY 1993 BUDGET REQUEST FOR SMT EDUCATION BY AGENCY AND MAJOR PROGRAM AREA

(IN MILLIONS) (Source: FCCSET-CEHR ANALYSIS)

MAJOR CATEGORIES	FY 92 Baseline	Total FY 93 Request	USDA	DOC	DOD	ED	DOE	HHS	DOI	SI	NSF	NASA	EPA
GRAND TOTAL	**1954.74**	**2092.23**	**22.65**	**3.68**	**415.97**	**392.53**	**113.21**	**416.45**	**88.43**	**10.04**	**537.20**	**82.27**	**9.80**
Precollege Total	650.71	767.95	0.72		4.97	371.20	32.39	21.84	25.30	0.63	286.20	16.70	8.00
Teacher Preparation/Enhancement	382.56	436.51			0.63	286.50	16.84	5.19	2.00	0.33	114.80	7.92	2.30
Curriculum Development	83.35	91.58				2.70	4.51	2.54	6.90	0.22	67.70	5.00	2.01
Comprehensive/Organizational Reform	87.69	104.05				20.00	3.58	4.14			74.00	0.29	2.04
Student Incentives	46.48	68.08	0.72		4.34	20.00	6.55	9.97	14.71		11.00	0.58	0.21
Program Evaluation and Studies, and Dissemination	41.73	58.74				42.00	0.57		0.15	0.08	13.80	0.70	1.44
Other	8.89	8.99					0.34		1.54		4.90	2.22	
Undergraduate Total	**444.25**	**480.77**	**13.50**		**176.20**	**21.00**	**56.87**	**25.00**	**8.72**		**146.30**	**32.38**	**0.80**
Faculty Preparation/Enhancement	36.66	49.22					11.52	0.08	1.82		30.80	5.00	
Curriculum Development	103.45	97.71			38.90		3.22	0.16	1.03		52.90	1.50	
Comprehensive/Organizational Reform	82.20	90.44	13.50		6.80	6.00		22.52	0.43		28.80	12.39	
Student Incentives	168.55	190.05			100.50	15.00	25.05	2.24	5.33		28.80	12.33	0.80
Other, includes education technologies, program evaluation and dissemination	53.40	53.35			30.00		17.08		0.11		5.00	1.16	
Graduate Total	**768.89**	**750.20**	**8.43**	**3.68**	**234.80**		**19.62**	**364.01**	**11.07**	**0.50**	**73.90**	**33.19**	**1.00**
Predoctoral Fellowships	99.77	99.54		0.30	16.70		8.21	5.64	0.10	0.09	52.40	15.30	0.80
Predoctoral Traineeships	180.28	160.81	4.00		3.90		0.55	128.99	10.42		8.40	4.35	0.20
Postdoctoral Fellowships	98.79	98.70		3.38	10.50		6.43	51.23	0.55	0.41	13.10	13.10	
Postdoctoral Traineeships	154.79	155.62	4.43				0.50	150.69					
Other	235.26	235.53			203.70		3.93	27.46			0.44		
Public Science Literacy Total	**90.89**	**93.32**				**0.33**	**4.34**	**5.60**	**43.34**	**8.91**	**30.80**		
Education Programs for Decision Makers	1.74	5.10					0.35		3.35		1.40		
Media Dissemination	21.73	22.09					1.13	1.21	3.25		16.50		
Public/Community-Linked Dissemination	56.90	59.50					1.34	3.23	33.12	8.91	12.90		
Public Information Campaigns	6.95	6.33				0.33	1.42	0.96	3.62				
Public Science Literacy Evaluation	3.57	0.30					0.1	0.2					

Overview Tables

Table I-1. Composition of the FY 1993 Budget (outlays in billions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
CURRENT DOLLARS				
National Defense	$273.3	$307.3	$291.4	-5.2%
R&D Included	(38.2)	(40.8)	(42.5)	4.1%
Payments and Grants[1]	712.2	798.2	844.3	5.8%
Net Interest	194.5	198.8	213.7	7.5%
Undistributed Offsetting Receipts	-39.4	-38.8	-41.6	7.4%
Other Government	182.3	209.9	207.5	-1.2%
R&D Included	(24.5)	(29.0)	(30.7)	5.9%
TOTAL Outlays	$1,323.0	$1,475.4	$1,515.3	2.7%
R&D Included	($62.8)	($69.8)	($73.2)	4.8%
Receipts	$1,054.3	$1,075.7	$1,165.4	8.3%
Deficit (-) or Surplus	-$268.7	-$399.7	-$349.9	-12.5%

Table I-1. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
CONSTANT FY 1987 DOLLARS				
National Defense	$238.5	$258.8	$237.5	-8.2%
R&D Included	(32.6)	(33.8)	(34.1)	0.7%
Payments and Grants[1]	596.4	649.8	665.9	2.5%
Net Interest	166.1	164.7	171.3	4.0%
Undistributed Offsetting Receipts	-33.2	-31.7	-33.0	4.1%
Other Government	155.0	173.1	165.8	-4.2%
R&D Included	(21.0)	(24.0)	(24.6)	2.5%
TOTAL Outlays	$1,122.8	$1,214.7	$1,207.5	-0.6%
R&D Included	($53.6)	($57.9)	($58.7)	1.5%
Receipts	$894.8	$885.6	$928.6	4.9%
Deficit (-) or Surplus	-$228.0	-$329.1	-$278.9	-15.3%

Source: *Budget of the United States Government, Supplement* (February 1992).

[1] Payments to individuals and grants-in-aid.

Table I-2. Historical Trends in R&D and Federal Outlays (in billions)

	FY 1970 Actual	FY 1980 Actual	FY 1990 Actual	FY 1993 Budget
COMPOSITION OF FEDERAL OUTLAYS (CURRENT DOLLARS)				
National Defense	$81.7	$134.0	$299.3	$291.4
Payments to Individuals and Grants[1]	80.1	336.9	641.8	844.3
Net Interest	14.4	52.5	184.2	213.7
Undistributed Offsetting Receipts	-8.6	-19.9	-36.6	-41.6
Other Government	28.1	87.4	163.0	207.5
TOTAL, Federal Outlays	$195.6	$590.9	$1,251.7	$1,515.3
Federal R&D Outlays Included:				
In National Defense	$8.3	$15.0	$41.6	$42.5
In "Other Government"	$7.5	$16.8	$23.7	$30.7
Total	$15.7	$31.8	$65.3	$73.2
COMPOSITION OF FEDERAL OUTLAYS (PERCENT)				
National Defense	41.8%	22.7%	23.9%	19.2%
Payments to Individuals and Grants[1]	40.9%	57.0%	51.3%	55.7%
Net Interest	7.3%	8.9%	14.7%	14.1%
Undistributed Offsetting Receipts	-4.4%	-3.4%	-2.9%	-2.7%
Other Government	14.4%	14.8%	13.0%	13.7%
TOTAL, Federal Outlays	100.0%	100.0%	100.0%	100.0%

Table I-2. (continued)

	FY 1970 Actual	FY 1980 Actual	FY 1990 Actual	FY 1993 Budget
FEDERAL R&D OUTLAYS AS PERCENT OF FEDERAL OUTLAYS				
Defense R&D as Percent of "National Defense"	10.1%	11.2%	13.9%	14.6%
Non-Defense R&D as Percent of "Other Government"	26.5%	19.2%	14.5%	14.8%
Total R&D as Percent of Total Federal Outlays	8.0%	5.4%	5.2%	4.8%
FEDERAL R&D OUTLAYS AS PERCENT OF GDP				
Defense R&D	0.8%	0.6%	0.8%	0.7%
Non-Defense R&D	0.8%	0.6%	0.4%	0.5%
Total Federal R&D	1.6%	1.2%	1.2%	1.2%

Source: Authors' estimates based on *Budget of the United States Government, Supplement* (February 1992).

[1] Payments to individuals and grants-in-aid.

Table I-3. Budget Authority, Obligations, and Outlays for R&D (in billions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Defense R&D				
Budget Authority	$40.4	$42.7	$43.3	1.3%
Obligations	37.1	44.5	43.0	-3.4%
Outlays	38.2	40.8	42.5	4.1%
Nondefense R&D				
Budget Authority	28.4	30.6	32.5	6.1%
Obligations	28.3	31.7	33.0	4.1%
Outlays	24.5	29.0	30.7	5.9%
Total R&D				
Budget Authority	68.7	73.3	75.7	3.3%
Obligations	65.3	76.3	76.0	-0.3%
Outlays	62.8	69.8	73.2	4.8%
Constant FY 1987 Dollars (Budget Authority Only)				
Defense R&D	$34.5	$35.4	$34.7	-2.0%
Nondefense R&D	24.2	25.3	26.0	2.7%
Total R&D	$58.7	$60.7	$60.7	0.0%

Source: OMB's data for R&D for FY 1993 and agency budget justifications. Constant dollar conversions based on OMB's GDP deflators.

Table I-4. Major Components of Federal Funding for R&D[1] (budget authority in billions)

	FY 1980 Actual	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93	Percent Share of Total	
						1980	1993
CURRENT DOLLARS							
Defense	$15.4	$40.4	$42.7	$43.3	1.3%	46.7%	57.1%
Nondefense[2]	17.6	28.4	30.6	32.5	6.2%	53.3%	42.9%
Space	4.8	7.5	7.8	8.3	7.4%	14.6%	11.0%
Health	4.2	9.7	10.4	10.9	4.1%	12.7%	14.4%
Energy	4.2	3.2	3.3	3.4	1.5%	12.7%	4.5%
General Science	1.4	3.0	3.5	4.1	17.6%	4.2%	5.5%
Natural Resources & Environment	1.0	1.7	1.7	1.7	-1.6%	3.0%	2.3%
Agriculture	0.6	1.2	1.3	1.2	-6.4%	1.8%	1.6%
Transportation	0.9	1.0	1.3	1.5	17.3%	2.7%	2.0%
All Other	0.5	1.1	1.2	1.3	8.8%	1.6%	1.7%
TOTAL R&D	$33.0	$68.7	$73.3	$75.7	3.3%	100.0%	100.0%

Table I-4. (continued)

	FY 1980 Actual	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93	Percent Share of Total 1980	Percent Share of Total 1993
CONSTANT FY 1987 DOLLARS							
Defense	$21.8	$34.5	$35.4	$34.7	-2.0%	46.7%	57.1%
Nondefense[2]	24.9	24.2	25.3	26.0	2.7%	53.3%	42.9%
Space	6.8	6.4	6.4	6.7	3.9%	14.6%	11.0%
Health	6.0	8.3	8.6	8.7	0.8%	12.7%	14.4%
Energy	6.0	2.7	2.8	2.7	-1.7%	12.7%	4.5%
General Science	2.0	2.6	2.9	3.3	13.8%	4.2%	5.5%
Natural Resources & Environment	1.4	1.4	1.4	1.4	-4.8%	3.0%	2.3%
Agriculture	0.8	1.0	1.1	1.0	-9.4%	1.8%	1.6%
Transportation	1.3	0.9	1.1	1.2	13.5%	2.7%	2.0%
All Other	0.7	1.0	1.0	1.0	5.3%	1.6%	1.7%
TOTAL R&D	$46.8	$58.7	$60.7	$60.7	0.0%	100.0%	100.0%

Source: Authors' estimates based on data from OMB, agency budget justifications, and *AAAS Report VI* (1981). Constant dollar conversions based on OMB's GDP deflators. Classifications generally follow the government's budget function categories except health (which here includes health R&D in HHS, VA, and Education).

[1] Includes conduct of R&D and R&D facilities.

[2] Includes all R&D not in defense.

Table I-5. R&D by Character of Work (budget authority in billions)

	FY 1980 Actual	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Share of Total FY 1980	Share of Total FY 1993
CURRENT DOLLARS						
Basic Research	$4.7	$12.4	$13.3	$14.3	14.2%	18.9%
Applied Research	6.9	11.9	12.8	13.4	20.9%	17.7%
TOTAL Research	$11.6	$24.3	$26.1	$27.7	35.2%	36.6%
Development	20.0	41.5	43.7	45.1	60.5%	59.5%
TOTAL Conduct of R&D	$31.6	$65.8	$69.8	$72.8	95.6%	96.1%
R&D Facilities	1.5	2.9	3.5	2.9	4.4%	3.9%
TOTAL R&D	$33.0	$68.7	$73.3	$75.7	100.0%	100.0%

Table I-5. (continued)

	FY 1980 Actual	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Share of Total FY 1980	Share of Total FY 1993
CONSTANT FY 1987 DOLLARS						
Basic Research	$6.7	$10.6	$11.0	$11.5	14.2%	18.9%
Applied Research	9.8	10.2	10.6	10.7	20.9%	17.7%
TOTAL Research	$16.4	$20.7	$21.6	$22.2	35.2%	36.6%
Development	28.3	35.5	36.2	36.1	60.5%	59.5%
TOTAL Conduct of R&D	$44.7	$56.2	$57.8	$58.3	95.6%	96.1%
R&D Facilities	2.1	2.5	2.9	2.4	4.4%	3.9%
TOTAL R&D	$46.8	$58.7	$60.7	$60.7	100.0%	100.0%

Source: OMB Data for R&D for FY 1993, as revised, and *AAAS Report VI* (1981). Constant dollar conversions based on OMB's GDP deflators.

Table I-6. Defense and Nondefense R&D by Character of Work (budget authority in billions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93	Percent By Category	Percent Of Total R&D
Basic Research						
Defense	$1.2	$1.2	$1.2	2.0%	8.6%	1.6%
Nondefense	11.2	12.1	13.1	8.6%	91.4%	17.3%
TOTAL	$12.4	$13.3	$14.3	8.0%	100.0%	18.9%
Applied Research						
Defense	3.5	3.9	3.9	1.8%	29.3%	5.2%
Nondefense	8.4	8.9	9.5	6.0%	70.7%	12.5%
TOTAL	$11.9	$12.8	$13.4	4.7%	100.0%	17.7%
Development						
Defense	34.7	36.4	37.2	2.3%	82.7%	49.2%
Nondefense	6.9	7.3	7.8	6.4%	17.3%	10.3%
TOTAL	$41.5	$43.7	$45.1	3.0%	100.0%	59.5%
Total Conduct of R&D						
Defense	39.3	41.5	42.4	2.3%	58.3%	56.0%
Nondefense	26.5	28.3	30.4	7.2%	41.7%	40.1%
TOTAL	$65.8	$69.8	$72.8	4.3%	100.0%	96.1%

Table I-6. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93	Percent By Category	Percent Of Total R&D
R&D Facilities						
Defense	1.0	1.3	0.9	-31.4%	29.4%	1.1%
Nondefense	1.9	2.2	2.1	-7.2%	70.6%	2.7%
TOTAL	$2.9	$3.5	$2.9	-15.9%	100.0%	3.9%
TOTAL R&D						
Defense	40.4	42.7	43.3	1.3%	57.1%	57.1%
Nondefense	28.4	30.6	32.5	6.1%	42.9%	42.9%
TOTAL	$68.7	$73.3	$75.7	3.3%	100.0%	100.0%

Source: OMB data for R&D for FY 1993, and agency supporting data.

Table I-7. R&D in Selected Agencies (budget authority in millions)[1]

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change, FY 1992-93 Current $	Percent Change, FY 1992-93 Constant $
Department of Defense	$37,208.5	$39,159.2	$40,083.8	2.4%	-0.9%
Department of Energy - Defense	3,166.5	3,571.9	3,192.0	-10.6%	-13.5%
TOTAL Defense	(40,375.0)	(42,731.1)	(43,275.8)	1.3%	-2.0%
Department of Energy - General Science	1,127.9	1,455.1	1,632.5	12.2%	8.6%
Department of Energy - Energy	3,044.3	3,224.3	3,267.7	1.3%	-1.9%
TOTAL DOE	(7,338.7)	(8,251.3)	(8,092.2)	-1.9%	-5.1%
National Aeronautics & Space Administration	8,123.9	8,561.6	9,303.4	8.7%	5.2%
National Science Foundation	1,893.4	2,065.0	2,508.0	21.5%	17.5%
National Institutes of Health	7,890.4	8,538.9	8,972.6	5.1%	1.7%
Other Health and Human Services	1,675.9	1,799.6	1,767.6	-1.8%	-4.9%
Department of Agriculture	1,391.1	1,497.7	1,403.2	-6.3%	-9.3%
Environmental Protection Agency	458.9	502.0	528.4	5.3%	1.9%
Department of Education	162.8	172.2	217.4	26.2%	22.2%
National Oceanic and Atmospheric Administration	348.1	399.4	382.2	-4.3%	-7.4%
National Institute of Standards and Technology	172.3	198.5	255.2	28.6%	24.4%
U.S. Geological Survey	359.9	366.7	329.3	-10.2%	-13.1%
Bureau of Mines	109.1	82.7	75.3	-8.9%	-11.9%
All Other	1,613.5	1,702.1	1,803.2	5.9%	2.5%
TOTAL Nondefense	(28,371.5)	(30,565.8)	(32,451.0)	6.2%	2.7%
TOTAL R&D	$68,746.5	$73,296.9	$75,726.8	3.3%	0.0%

Source: OMB data for R&D for FY 1993, and agency budget justifications.

[1] Includes conduct of R&D and R&D facilities.

Table I-8. Conduct of Basic Research by Agency in Current Dollars (budget authority in millions)

	FY 1980 Actual	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change, FY 1992-93 Current $	Percent Change, FY 1992-93 Constant $
Health and Human Services	$1,762	$5,021	$5,459	$5,800	6.3%	2.8%
National Institutes of Health	(1,644)	(4,608)	(5,019)	(5,328)	6.1%	2.7%
National Science Foundation	830	1,750	1,839	2,221	20.8%	16.9%
Defense (Military)	552	1,157	1,181	1,204	2.0%	-1.3%
Energy	523	1,685	1,789	1,867	4.4%	1.0%
National Aeronautics & Space Administration	559	1,725	1,860	2,068	11.1%	7.6%
Agriculture	280	553	611	639	4.6%	1.2%
Interior	72	229	218	193	-11.4%	-14.2%
Smithsonian	41	104	107	125	16.8%	13.1%
Commerce	31	34	35	39	12.1%	8.5%
Veterans Affairs	14	16	17	17	0.6%	-2.6%
Education	18	5	5	4	-14.0%	-16.8%
Environmental Protection Agency	13	92	104	117	12.6%	8.9%
Agency for International Development[1]	--	5	11	9	-11.3%	-14.2%
Other	21	31	30	19	-38.5%	-40.5%
TOTAL, Basic Research	$4,716	$12,407	$13,265	$14,322	8.0%	--
TOTAL Basic Research (Constant FY 1987 Dollars)	$6,682	$10,596	$10,988	$11,482	--	4.5%

Source: OMB data for R&D for FY 1993 and agency supporting data.

[1] Reported under "Other" in 1980.

Table I-9. Estimated Support for Conduct of R&D at Colleges and Universities in Current Dollars (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change, FY 1992-93 Current $	Percent Change, FY 1992-93 Constant $
Health and Human Services	$5,381	$5,804	$6,071	4.6%	1.2%
National Institutes of Health	(4,552)	(4,922)	(5,181)	5.3%	1.9%
National Science Foundation	1,446	1,597	1,917	20.1%	16.2%
Defense (Military)	1,483	1,417	1,445	2.0%	-1.3%
Agriculture	386	425	417	-2.0%	-5.2%
Energy	626	629	591	-6.0%	-9.0%
National Aeronautics & Space Administration	595	632	675	6.8%	3.4%
Agency for International Development	79	64	48	-23.9%	-26.4%
Environmental Protection Agency	69	71	75	6.4%	2.9%
Education	99	108	125	15.7%	12.0%
Interior	58	48	34	-30.4%	-32.7%
Transportation	21	29	32	9.6%	6.1%
Commerce	59	62	46	-12.5%	-27.4%
Other	24	25	26	4.8%	1.5%
TOTAL, Current Dollars	$10,326	$10,910	$11,501	5.4%	--
TOTAL, Constant FY 1987 Dollars	$8,819	$9,037	$9,220	--	2.0%

Source: OMB data for R&D for FY 1993 and agency supporting data. Constant dollar conversions based on OMB's GDP deflators.

Table I-10. National Pattern of R&D: Estimated 1991 Expenditures and 2-Year Constant Dollar Changes 1989-91 (in millions)

	SOURCES OF FUNDS				
	Federal Government	Industry	Colleges & Universities	Non-Profit Institutions	Total Funds for R&D
Estimated Expenditures, 1991:					
Federal	$16,400	$0	$0	$0	$16,400
Industry	32,300	76,150	0	0	108,450
Colleges & Universities	9,650	1,250	4,950	1,350	17,200
FFRDC[1]	4,850	0	0	0	4,850
Nonprofits	2,800	650	0	1,250	4,700
TOTAL, Performers	$66,000	$78,050	$4,950	$2,600	$151,600
Two Year % Change In Constant 1987 Dollars (1989 - 1991):					
Federal	0.3%	--	--	--	0.3%
Industry	-4.8%	0.2%	--	--	-1.3%
Colleges & Universities	-0.6%	17.4%	15.9%	15.2%	6.1%
FFRDC[1]	-5.2%	--	--	--	-5.2%
Nonprofits	3.5%	9.2%	--	15.5%	7.3%
TOTAL, Performers	-2.7%	0.5%	15.9%	15.4%	-0.3%

Source: National Science Foundation, *Science and Engineering Indicators 1991*. Constant dollar conversions based on OMB's GDP deflators. Amounts represent current operating costs based on data from performers of R&D and therefore do not correspond exactly to the figures for R&D elsewhere in this report. Capital expenditures for R&D are generally excluded.

[1] Federally Funded Research & Development Centers.

Table I-11 National Funds for R&D by Source of Funds (in millions of dollars)

	1970 Actual	1980 Actual	1990 Prelim.	1991 Est.	Percent Share of Total		
					1970	1980	1991
CURRENT DOLLARS							
Federal	$14,891	$29,461	$64,000	$66,000	57.0%	47.1%	43.5%
Industry	10,444	30,912	74,700	78,050	40.0%	49.4%	51.5%
Colleges & Universities	462	1,334	4,450	4,950	1.8%	2.1%	3.3%
Nonprofits	337	903	2,300	2,600	1.3%	1.4%	1.7%
TOTAL	$26,134	$62,610	$145,450	$151,600	100.0%	100.0%	100.0%
CONSTANT 1987 DOLLARS							
Federal	$43,075	$41,741	$56,803	$56,367	57.0%	47.1%	43.5%
Industry	30,211	43,797	66,300	66,658	40.0%	49.4%	51.5%
Colleges & Universities	1,336	1,890	3,950	4,228	1.8%	2.1%	3.3%
Nonprofits	975	1,279	2,041	2,221	1.3%	1.4%	1.7%
TOTAL	$75,597	$88,708	$129,094	$129,473	100.0%	100.0%	100.0%
Total R&D as % of GDP	2.7%	2.7%	2.7%	2.7%			

Source: National Science Foundation, *Science and Engineering Indicators 1991*. Constant dollar conversions based on OMB's GDP deflators. GDP estimate based on GDP data in the *Budget of the United States Government, Supplement* (February 1992). Amounts represent current operating costs based on data from performers of R&D and therefore do not correspond exactly to the figures for R&D elsewhere in this report. Capital expenditures for R&D ar[illegible]nerally excluded.

Table I-12 National Funds for R&D by Performers (in millions of dollars)

	1970 Actual	1980 Actual	1990 Prelim.	1991 Est.	Percent Share of Total 1970	Percent Share of Total 1980	Percent Share of Total 1991
CURRENT DOLLARS							
Federal	$4,079	$7,632	$16,100	$16,400	15.6%	12.2%	10.8%
Industry	18,067	44,505	104,200	108,450	69.1%	71.1%	71.5%
Colleges & Universities	2,335	6,077	16,000	17,200	8.9%	9.7%	11.3%
FFRDC[1]	737	2,246	4,800	4,850	2.8%	3.6%	3.2%
Nonprofits	916	2,150	4,350	4,700	3.5%	3.4%	3.1%
TOTAL	$26,134	$62,610	$145,450	$151,600	100.0%	100.0%	100.0%
CONSTANT 1987 DOLLARS							
Federal	$11,799	$10,813	$14,290	$14,006	15.6%	12.2%	10.8%
Industry	52,262	63,056	92,482	92,621	69.1%	71.1%	71.5%
Colleges & Universities	6,754	8,610	14,201	14,690	8.9%	9.7%	11.3%
FFRDC[1]	2,132	3,182	4,260	4,142	2.8%	3.6%	3.2%
Nonprofits	2,650	3,046	3,861	4,014	3.5%	3.4%	3.1%
TOTAL	$75,597	$88,708	$129,094	$129,473	100.0%	100.0%	100.0%
Total R&D as % of GDP	2.7%	2.7%	2.7%	2.7%			

Source: National Science Foundation, *Science and Engineering Indicators* 1991. Constant dollar conversions based on OMB's GDP deflators. Amounts represent current operating costs based on data from performers of R&D and therefore do not correspond exactly to the figures for R&D elsewhere in this report. Capital expenditures for R&D are generally excluded.

[1] Federally Funded Research & Development Centers.

Table I-13. Industry Spending for R&D by *Business Week* Groupings, 1990 (in millions)

Industry	1990	Percent Change from 1989
Aerospace	$3,916.3	0.0%
Automotive	10,710.3	5.0%
Chemicals	5,160.2	10.0%
Conglomerates	3,668.5	8.0%
Consumer Products	1,934.6	11.0%
Containers and Packaging	93.8	8.0%
Electrical and Electronics	7,042.4	11.0%
Electrical Products	763.5	9.0%
Electronics	2,538.9	13.0%
Instruments	1,300.6	3.0%
Semiconductors	2,439.3	13.0%
Food	526.3	11.0%
Fuel	2,712.6	7.0%
Health Care	8,535.4	20.0%
Drugs and Research	6,203.5	22.0%
Medical Products and Services	2,331.9	14.0%
Housing	505.7	3.0%
Leisure Time Products	1,798.2	5.0%
Manufacturing	3,237.7	10.0%
Metals and Mining	405.8	13.0%
Nonbank Financial	88.8	24.0%
Office Equipment and Computers	15,953.7	5.0%
Business Machines and Services	241.0	12.0%
Computer Communications	414.7	17.0%
Computers	11,876.5	1.0%
Data Processing	183.7	16.0%
Disk and Tape Drives	498.9	43.0%
Peripherals and Other Devices	1,150.4	8.0%
Software and Services	1,162.6	28.0%
System Design	425.9	8.0%
Paper and Forest Products	391.8	7.0%
Publishing and Broadcasting	12.9	281.0%
Service Industries	115.9	18.0%
Telecommunications	3,178.5	-5.0%
TOTAL	$69,989.5	7.0%

Source: Based on *Business Week*, "R&D Statistics." Reprinted from the October 25, 1991 Quality issue by special permission. © 1991 by McGraw-Hill Inc.

NOTE: Based on SEC data for companies reporting 1990 sales of $35 million or more, and R&D expenses amounting to at least $1.0 million or at least 1.0 percent of sales.

Part II: Agency R&D Budgets

Introduction

In this section, R&D in the federal budget is examined through the agencies that support and perform the work. Separate chapters examine the R&D activities of the principal R&D agencies. These are followed by budget tables, starting with a summary table of R&D budget totals by agency from FY 1991 to FY 1993, and followed by detailed budget tables for each major agency, to support discussions of the Bush Administration's programs and policies for R&D.

The discussions of agency R&D programs assess budget trends and policy choices reflected in the FY 1993 budget in as detailed a manner as possible. Some agencies have been treated in greater depth than others, reflecting differences in availability of information or issues of special importance. Aspects of certain important agency R&D budgets which do not appear in this section may be found in the disciplinary chapters in Part III. For instance, although there is no chapter devoted to NOAA in this section, a discussion of its programs is contained in Chapter 14, "FY 1993 R&D in the Atmospheric and Oceanic Sciences."

Budget figures in the detailed agency tables may not correspond exactly to the amounts in the summary tables here and elsewhere in the report. The data in the summary tables were generally prepared based on OMB and NSF data, while the agency tables were derived using agency budget justifications. R&D is often not managed or budgeted by the agencies in categories that correspond exactly to those used by OMB and NSF for statistical purposes. Where significant differences have been found, they are discussed in footnotes to the agency tables.

Where trends in constant dollars are shown, our calculations are based on the fiscal year deflators developed by OMB.

Agency Summary

The composition by agency of total R&D (conduct and facilities) is shown in Table II-1. The numbers are drawn directly from the budget authority data compiled by OMB for their analyses of the FY 1993 budget.

The last column of the table shows the percentage change in constant dollars from FY 1992-93 -- "real" dollar figures, intended to reflect trends in the purchasing power of agency R&D allocations. These figures highlight several trends discussed in detail in the sections that follow.

Chapter 5

R&D in the FY 1993 Department of Defense Budget

American Association for the Advancement of Science

Paul R. Gehman, Jr., Albert H. Teich

Highlights

- The overall defense budget continues to shrink. President Bush's FY 1993 budget request for the Department of Defense (DOD) is $267.6 billion in budget authority. This compares to a FY 1992 request of $278 billion and an appropriated level of $271 billion.

- Defense R&D would grow slightly in the proposed budget. Total DOD R&D in the FY 1993 request is estimated at $40.1 billion, up from an estimated $39.2 billion in FY 1992, a 2.4 percent increase. (See Tables II-2, 3 and 4.)

- Spending for research, exploratory development, and advanced technology development would grow significantly in FY 1993. The President's request includes obligational authority of $11.8 billion for these areas, compared to $10.7 billion in FY 1992. (See Table II-2.) The growth reflects, in Defense Secretary Cheney's words, "DOD's emphasis on leading-edge research, funding for Science and Technology . . . not geared to a specific weapon."

- The strongest growth in FY 1993 would be in advanced technology development. The request of $7.7 billion for FY 1993 represents an increase of 18.4 percent over the FY 1992 level of $6.5 billion, reflecting the Administration's new emphasis on pre-deployment and procurement prototyping and demonstration in a number of areas, including SDI. (See Table II-2.)

- Defense basic research would increase only slightly in FY 1993, up a modest 2.0 percent over its estimated FY 1992 budget authority level of $1.18 billion. Deletions of pork barrel items from the University Research Initiative offset increases in other program elements. If these are excluded from the calculation, the growth in basic research appears more substantial. (See Tables II-4 and 5.)
- The Strategic Defense Initiative Organization would receive $5.3 billion in budget authority, a 29.1 percent increase over FY 1992. (See Table II-3.) The reorganized presentation of budget elements reflects the integration of the Theater Missile Defense programs with SDI.

The Defense Budget and the Defense Environment

What a difference a year makes. The world situation and U.S. defense needs have changed dramatically. New threat assessments, mission changes, and force restructurings have resulted in proposals for deep cuts to the DOD budget over the next five years, beyond those already in the works a year ago.

The focus of national security policy has shifted from containment directed against a superpower and potential global conflict to regional contingencies via a regional defense strategy. Now codified as the "National Military Strategy," its four components include: (1) strategic deterrence and defense; (2) a downwardly rescaled forward presence within the largely continental U.S. base force; (3) flexible and adaptive crisis response capabilities; and (4) reconstitution capabilities. R&D efforts support all four components of this strategy.

The value of technological superiority was a central lesson of 1991. Refining last year's statement to Congress that the 1990s will be a "decade of development, more than of production," Secretary

Cheney recently outlined to Congress the Administration's new acquisition strategy. This approach emphasizes technology demonstration and prototype evaluation to assess capabilities and prove out concepts, as well as manufacturing technologies.

The new acquisition strategy has at least four components relevant to R&D:

- increased research on advanced technologies and processes for application in future weapon systems;
- increased development and evaluation of demonstrators and prototypes using advanced technology;
- selected incorporation of advanced technologies in existing weapons systems (under conditions of thorough testing, established need for improved performance or reliability, and cost-effectiveness);
- production of new weapon systems using advanced technology (again, under conditions of thorough testing, minimized technical, production, and operational risks, cost- effectiveness, and verified need).

The new strategy has enormous implications for DOD contractors and subcontractors. As Deputy Secretary of Defense Donald Atwood recently stated, the new approach to acquisition is going to put greater emphasis on R&D. However, contractors will no longer be able to recoup the R&D expenses they incur in the early stages of the acquisition cycle in subsequent production costs and fees.

DOD will be putting increased funds into research on new and advanced technologies for application and future weapons systems. Most, however, will not go into production in the immediate future. The investments are intended to provide a better store of technologies for future application. There will be increased emphasis on development and evaluation of technology demonstrators and prototypes -- not just to check out product design, but also to test new manufacturing techniques. As this new emphasis on R&D has evolved, it has been accompanied by actual and proposed procurement terminations -- over 100 weapons systems within the last two years.

Research Priorities in the Armed Services

Each of the armed services maintains its own research program in key technologies and basic sciences relevant to its missions. The services' research programs fare rather differently under the new acquisition strategy, with the Navy and the Air Force doing much better than the Army.

Army Research

Funding for Army RDT&E would decline by 17.0 percent, to $5.4 billion under the FY 1993 proposals. Research, Exploratory Development, and Advanced Technology Development all receive cuts relative to their FY 1992 levels.

The Air-Land battle concepts that were implemented by the armored, mechanized, and air cavalry divisions in the Gulf War did not reveal essential weaknesses in the Army's tank or helicopter systems. Thus, implementing current plans for an 8,000-strong tank force will not require crash research programs for near-term replacements, and research concerned with follow-on systems can proceed at a more measured pace. Technology Base programs are slated to fall by 14.7 percent to $753.3 million in FY 1993.

In FY 1992 deliberations, the House added funds to the Army's primary basic research line item, Defense Research Sciences, while the Senate reduced funding for this program. For FY 1993, the Administration has requested $166.6 million, a cut of 12.7 percent. Within basic research, funding for one hot item, Electromechanics and Hypervelocity Physics, will grow 31.4 percent to $3.9 million in FY 1993. Weaponry emerging from this research program has the potential to vastly increase delivery speeds over current chemical based designs.

Much of the Army's basic research is aimed at improving the knowledge base underlying its three "platforms": the soldier, the armored vehicle, and the vertical lift vehicle. Design features must accommodate power projection needs of speed, quickness, lethality, mobility, and survivability. These platforms are relatively small in scale, compared to other services' traditional platforms, and so constrain the R&D enterprise.

Among the investigations underway are studies of how to keep the soldier safe and comfortable in adverse environments. Key to armored vehicle studies are the problems of designing skins capable of repelling hypervelocity anti-armor weaponry. These include materials research into composites, smart and responsive armor that senses, actuates and responds; piezoelectric response materials; and the next generation of ceramics capable of absorbing forward momentum and transferring the force laterally. Finally, in the area of the vertical lift vehicle (i.e., helicopter), a central concern is command and control -- design features that allow the pilot more freedom of attention. Autonomous control features that sense terrain, threats, and environment are another research driver.

Navy Research

The budget for Navy RDT&E would increase by 11.0 percent under the proposed FY 1993 budget, from $7.7 to $8.5 billion. Research, Exploratory Development, and Advanced Technology Development would all grow.

The primary line item that supports Navy-relevant basic science and technology is Defense Research Sciences. The budgeted increase to $457.4 million in FY 1993 represents close to a 20 percent boost above the FY 1992 level. Basic research designed to both exploit emerging scientific and technological breakthroughs that are Navy-relevant and at the same time prevent surprises, is conducted in four general areas: the broad sustaining program and three core competencies of small-scale ocean sciences, advanced materials, and information sciences. The sustaining program supports research into the essential properties of materials, ocean systems, and the information sciences, prior to any research program's developing into a core competency. Research into testing, computer aided training, and education to make technologically literate sailors and naval aviators is also contained within the sustaining program.

The ocean science category includes research into the properties of ocean acoustics for detection, tracking, evasion, and communication purposes; ocean optics; and small-scale physical oceanography (within the range of 10-to-100 kilometers) versus large scale, systems oceanography. Advanced materials research exploits scientific breakthroughs, including work on diamond films, superconductive materials, marine biological adhesives, polymers, and ceramics. Investigations into the science of corrosion and repair, friction and wear of surfaces in adverse ocean environments are research concerns. Information sciences investigates data compression techniques, non-linear chaotic processes, real time computing, and naval applications for massively parallel computing and software advances. Modeling of ocean systems to enhance forecasting and prediction are also supported within the program area.

Air Force Research

The budget for Air Force RDT&E would rise by 5.8 percent to $14.5 billion in FY 1993. Research, Exploratory Development, and Advanced Technology Development all would increase.

The role of the Air Force in the Gulf War -- measured by sortie counts, recorded on video, testified to by interviewed pilots, and explained in battlefront and Pentagon press briefings, undoubtedly will influence future planning and research efforts. The air component of the Air-Land plan produced dramatic results, achieving tactical and strategic command of the skies quickly. As a power projection element, the Air Force can move quickly over great distances with force. The strategic doctrine of "global reach, global power" shapes Air Force research: longer distances need to be flown on shorter notice. Growth areas in Air Force basic research include: (1) the environment; (2) air vehicle/missile superiority; (3) generic investigations into the human being and new materials; and (4) space and near-space utilization.

The environment of the air vehicle is not well characterized for new shapes, new speeds, new engine designs, and new materials. Fluid mechanics studies external aerodynamic and internal fluid properties, unsteady and separated flows, and turbulence prediction and control. The effects on the environment of fuels and propellants, new and proposed, are also being investigated.

Another major research thrust relates to human capabilities. Included are measurements and assessment research to determine the right batteries of tests for personnel in highly technical environments; scoring and training research; learning and memory research. Interfaces between humans and machines are being developed which take environmental, threat, and machine performance data and transform it into usable information for the human operator. Research into new materials relevant to Air Force needs include those with stealth characteristics, and high temperature/high strength materials for skins and engine components.

The use of space and the near-atmosphere, together with the need for accurate long-range sensors and long-range strike capabilities, drive research into hypersonics, smooth transitioning from air-breathing engines to space propulsion systems without staging, unconventional propulsion such as ionic and nuclear systems, and data fusion.

Research Priorities in DARPA

The budget for RDT&E in the Defense Advanced Research Projects Agency (DARPA) would decline by 17.2 percent to $1.3 billion under the Administration's FY 1993 request. In part, the reduction is the result of the Administration's decision not to request funding for programs initiated by Congress in FY 1992.

DARPA is playing a central role in the FCCSET Initiative in High Performance Computing and Communications (HPCC). (See Chapter 1 for a brief discussion of these initiatives.) The agency's request for FY 1993 is $275.0 million, up from $232.2 million. DARPA is funding over a third of the government-wide efforts to develop the next generation of hardware architectures, communication networks, and software. DARPA's efforts include $119.5 million in high performance computing systems; $49.7 million in advanced software technology and algorithms; $43.6 million for the National Research and Education Network; and $62.2 million in basic research and human resources, primarily individual investigator and multidisciplinary studies.

DARPA has frequently been the recipient of legislative add-ons. In FY 1992 legislation, (as reported in AAAS's *Congressional Action on R&D in the FY 1992 Budget*) most of the additions seemed aimed at establishing a congressionally driven role for DARPA in dual-use technology development. Funding was added for X-ray lithography supporting advanced integrated circuit production ($60.0 million), as well as for a new five-year, $10 million initiative involving national laboratories, industry, and universities. Increments were also added for integrated command and control technology, including $75 million for HDTV and $60 million for precompetitive technology development.

In the FY 1993 budget, within the technology base category, DARPA makes no request for "integrated command and control technology." Estimated budget authority for FY 1992 was $109.6 million. Also decreasing from the previous year is the request for "materials and electronic technology" which goes from an appropriation of $187.5 million to $71.8 million. In addition, DARPA makes no request for "precompetitive technology development" within Advanced Technology Development which received an appropriation of $60 million in FY 1992.

Strategic Defense Initiative Organization (SDIO)

Continuing the turnabout in the fortunes of the Strategic Defense Initiative (SDI) begun last year, the budget for RDT&E in SDIO would increase by 29.1 percent, from $4.1 to $5.3 billion. Space Based Interceptors would go up by 23.5 percent to $575.6 million. Limited Defense Systems would rise by 48.8 percent to

$2.1 billion. Theater Missile Defenses, now integrated into SDIO, would increase 6.9 percent to $858 million and other follow-on systems would go up a similar amount.

Six broad areas of mission-specific R&D are supported by SDIO: High speed processing research refers to both signal processing and information processing. Data fusion techniques merge information gathered from multiple sources. Research also includes massively parallel and massively interconnected systems and artificial neural networks. Sensors research is carried out into IF focal plane arrays, for instance, and into visible, infrared, ultraviolet, and radar detectors in all-weather conditions and geographic directions. Propulsion and propellants research is conducted into the chemistry of energy-intense rocket fuels, downsizing rocket designs, alternative propulsion systems, and electric propulsion systems. Research on directed and kinetic energy concepts investigates such weapons as gamma ray lasers, particle beams, and hypervelocity guns. Power and power conditioning research explores electric power generation in space, management of energy, solar and nuclear issues, and energy transformation from source to system needs. Finally, materials and structures research is conducted in four areas: optical materials; high speed electronics and nonvolatile memory; superconducting materials for sensors and energy storage; and high-strength structural materials.

A particularly intriguing element contained within the request for SDI is a plan to acquire antiballistic missile (ABM) technologies and specialists from Russia. The proposal calls for acquiring ABM technologies in approximately 50 areas and employing directly or indirectly 1,000 scientists and engineers. The issues are politically, economically, and technologically complex. Is it appropriate for the Pentagon to support R&D efforts within the boundaries of the former Soviet Union? Is this preferable to having those technologies and specialists marketed to other allied or less friendly countries? The highest priority items for acquisition include: efficient electric thrusters, liquid rocket engines, space-based nuclear power systems, Soviet-designed ballistic missiles and experimental data, high speed and high temperature electrical switches, and neutral particle beam technologies.

University Research Initiative

In recent years, the University Research Initiative (URI), begun in the 1980s as a means of restoring ties between DOD and the universities, has become a vehicle for Congress to add pork barrel items to the defense budget. The Defense Appropriation bill for FY 1992 included more than $150 million in such items; they have been dropped from the FY 1993 request and the Administration has proposed rescinding some of the FY 1992 funds. This rescission is unlikely to be accepted by Congress and is not shown in Table II-5, resulting in an 55.8 percent decline in URI. It is important to recognize that this is not a programmatic cut in DOD's basic research efforts.

Also worth noting in Table II-5 is $80 million in FY 1993 for a "Defense Health Program." This represents the aggregation into a single line-item research efforts that were formerly funded elsewhere in the RDT&E budget. Whether the $80 million total is more or less than was spent for these programs in past years is cannot be ascertained from the information available.

Outlook

The Bush Administration's FY 1993 budget, as originally sent to Capitol Hill on January 29, was unusual in that it contained no detail on the defense budget. In fact, budget figures for defense RDT&E were so late in coming that for a while it seemed that it would not be possible to include them in this volume. In the end, program changes, proposed rescissions, and changes in presentation format have resulted in more uncertainty and ambiguity in this year's DOD budget than in most other years. The delays and confusion are characteristic of the turbulent environment in which defense RDT&E and the defense budget as a whole find themselves in 1992. It seems likely that this turbulence will continue throughout the coming congressional session and beyond.

On one side are pressures to reduce overall defense spending in response to budget pressures and the diminished threat of strategic nuclear war and military confrontation on a global scale. On the other side are the need to maintain a position of readiness in a considerably more fluid world situation, with no shortage of enemies and potential conflicts. The political and economic impacts of reducing defense spending -- local, regional, and national -- are other factors conditioning the environment. Then there is the growing international economic competition and the past and future role of defense R&D in pushing forward technology in areas relevant to the civilian economy.

The influence of all of these and other factors will be felt both within the Administration and in Congress in coming months and years. Members of Congress who advocate deep reductions in defense spending are not deterred from objecting to those cuts that impact their constituents. An Administration internally divided over the government's role in improving U.S. economic competitiveness rejects congressional initiatives aimed at enhancing DARPA's contribution to the domestic economy while promoting its own initiatives that do not seem all that different, either ideologically or substantively. Where these debates and cross-pressures will lead is far from clear. What does seem clear is that the budget process for FY 1993 is not likely to yield a definitive resolution to the issues facing defense R&D.

Chapter 6

National Science Foundation, FY 1993

Association of American Universities

Howard J. Gobstein, Kathie Bailey-Mathae

Highlights

- The 1993 budget sustains the President's (revised) commitment to double the NSF budget by 1994. The budget requests $3 billion, an increase of $450 million.
- NSF would strengthen the research base with an 18 percent increase for individual investigators and small groups.
- NSF plays a key role in FCCSET Presidential Initiatives involving R&D in the following areas:
  — advanced materials and processing ($319 million)
  — biotechnology ($206 million)
  — high performance computing and communications ($262 million)
  — global change ($163 million)
- NSF is heavily involved in the President's Mathematics and Science Education Initiative. The Foundation's budget would support approximately 41,400 graduate and undergraduate students at some

1,200 colleges and universities; and provide $286 million for programs at the precollege level, focusing on improving the effectiveness of elementary and secondary school science and mathematics instruction.

NSF's Balancing Act: Linking National Priorities and Scientific Needs

> "New products, new industries, and more jobs require continuous additions to knowledge of the laws of nature, and [its] application to practical purposes. This essential, new knowledge can be obtained only through basic scientific research." "Basic research is performed without thought of practical ends." *(Science — The Endless Frontier)*

> "Increasing funding for basic research should help preserve our lead in science, engineering, and technology, so that our industries can remain competitive internationally, while maintaining our standard of living at home." "The Committee applauds the Administration's commitment to double NSF's budget by 1992." (Senate Committee on Labor and Human Resources, Report 100-148, August 7, 1987.)

From its genesis following the 1945 Bush report, *Science — the Endless Frontier,* NSF has had to carefully balance its message between its benefactors (principally the Congress) and its performers (scientists). As the Foundation sells its programs to its benefactors based on its long-term utility, NSF attempts to assure its performers that this same work is also "basic" research, driven by nothing but curiosity and excellence.

The unique importance of the Foundation prompted the Administration and the Congress in 1988 to set a goal of doubling the NSF budget over the next five years. Although this objective has slipped several years, it has undoubtedly provided greater funding for academic scientists, particularly in the increasingly constrained federal budget. For example, although the Congress did not approve the full budget request for NSF for 1992, the agency received the highest percentage increase of the R&D agencies funded in the same appropriations bill. NSF's total budget increased an amazing

15.6 percent, with research and related activities increasing 10.1 percent over 1991.

The NSF budget for 1993 is the first one in which Director Walter Massey has participated in the entire cycle. It is being proposed at a time when the congressional staff estimate that there will be a several billion dollar shortfall in the relevant appropriations subcommittee allocation.

This year NSF demonstrates its utility to the nation by having a large piece of the President's Initiatives coordinated by FCCSET. NSF plays a key role in virtually all the high priority research issues of the year — global change, biotechnology, high performance computing, science and math education, and materials research. These efforts account for about half NSF's requested increase for 1993.

NSF seems to have managed to stay true to its basic mission, even while linking with the allure of the major initiatives. Over 70 percent of the research and related activities budget is for principal investigators and small groups. Approximately three quarters of the research funding under the global change initiative will be for investigator-initiated research, as will about 60 percent of the increase for the high performance computing initiative.

The challenge to the Foundation is to continuously find ways to link the NSF program to the public's more immediate needs while not forsaking investment in the more traditional research base from which future discoveries will come. The challenge to the entire research community is to more effectively educate the public to recognize the need for the full range of problem-focused and non-targeted research as complementary bases to address future societal needs. Only by such education will there be any hope to complete the doubling of the NSF budget and continue to build the nation's vital investment in scientific knowledge to enhance our nation's future.

Summary of the FY 1993 Budget Request

	FY 1993 Request	$ Increase	% Increase
	(In Millions of Dollars)		
Research & Related Activities	2,212	336.5	17.9
Education	479.5	14.5	3.1
Instrumentation	33.0	0	0
Antarctic	163*	74.6	85.2
Critical Technologies Institute	1	1	—
Salaries & Expenses	135	25.9	23.9
Inspector General	4	0.5	14.3
Total	3,027	453.5	17.6

* An additional $14 million is proposed as part of the FY1993 DOD budget request.

Special Programs and Initiatives

- Academic Research Instrumentation $33 million

  This is a competitive program for high-cost state-of-the-art instruments requiring "at least" 50 percent cost-sharing.

- Research Facilities 0

  Once again, no funding is requested for modernization of facilities. Last year, responding to a similar request for no funds, Congress split $33 million between facilities and instrumentation.

- High Performance Computing and Communications (HPCC) $262 million

  NSF plays a co-leadership role in this government-wide initiative coordinated by FCCSET. Funding would be increased 30 percent above last year's level and will focus on "grand challenges" and basic research.

- Global Change $162 million

  NSF plays a leading role in this FCCSET initiative. The 50 percent increase would be used largely for basic research.

- Biotechnology $205.6 million

  Funding for this cross-disciplinary research FCCSET initiative would be increased by 18 percent.

- Research Awards

  Assuming full funding of the request for Research and Related Activities, the average research award would increase $4,700 to $117,600. The number of awards would increase 13.2 percent to 18,798.

Activity Summaries

Biological Sciences $320.6 million +16.9 percent

- The Directorate for Biological Sciences was established in FY 1992. About 90 percent of total resources are allocated to individual investigators.

- BIO provides over 50 percent of federal funding for basic research in plant biology and over 70 percent in environmental biology at colleges and universities.
- BIO will serve as the lead activity in coordinating NSF's portion of the Biotechnology FCCSET initiative. A total of $15.2 million will support this effort.

Computer & Information Science and Engineering — $272.2 million — +29.1 percent

- NSF provides 60 percent of federal academic research funding in these fields.
- CISE is the lead activity in NSF's High Performance Computing and Communications Program. CISE will fund $229.0 million of the Foundation's total support of this initiative, an increase of $44 million.
- College and university infrastructure in computing research and education will be strengthened ($4.7 million), and advanced scientific computing and networking facilities for the U.S. research and education community will be enhanced ($19.0 million).

Engineering — $312.5 million — +20.9 percent

- NSF provides about 30 percent of the total federal support for engineering research at U.S. colleges and universities.
- ENG will participate in several interagency FCCSET initiatives and two NSF-wide initiatives in manufacturing and the environment.
  - Advanced Materials and Processing: $45.8 million, an increase of $18.4 million.
  - HPCC: $10.5 million, an increase of $3.1 million.
  - Biotechnology: $28.4 million, an increase of $5.2 million.

  — Manufacturing Research: an increase of $13.2 million.
- $53.2 million (up $5.7 million) would be provided for Engineering Research Centers. About $4 million will be used to establish centers related to advanced intelligent manufacturing and materials synthesis and processing. The remaining $1.7 million will be used to enhance the capacity of selected existing ERCs.
- $12.1 million (up $3 million) will be provided for the four existing Engineering Education Coalitions and up to two new groups. These organizations are developing new approaches to undergraduate engineering education.
- Research Experiences for Undergraduates would increase by $2.5 million, for a total of $4.4 million.

Geosciences $472.4 million +16.8 percent

- GEO provides about 70 percent of the federal support for basic geosciences research conducted at U.S. universities, and about 70 percent of the federal support for arctic-related research at U.S. academic institutions.
- Support for individual investigators will increase by $40.2 million, or 15.2 percent.
- Funding for the FCCSET Global Change program will increase to $133.7 million, up 49 percent. Increases for other FCCSET initiatives are:
  — Biotechnology: an increase of $1.9 million.
  — HPCC: an increase of $1.7 million.
  — education activities for special postdoctoral and undergraduate programs: an increase of $2.2 million.

Mathematical and Physical Sciences — $726 million — +16.5 percent

- NSF provides 38 percent of federal support for academic- research in these disciplines, and is the major source of support in ground-based astronomy, core mathematics and gravitational physics.
- MPS will have substantial participation in the FCCSET Initiatives.
  - — Advanced Materials: $187.6 million, up $24.9 million.
  - — HPCC: $19.1 million, up $4.5 million.
  - — Biotechnology: $19.3 million, up $5.4 million.
- Within Astronomical Sciences, the $7.1 million increase will be directed toward the highest priorities in the National Academy of Sciences NAS report on astronomy and astrophysics — infrastructure at the National Astronomy Centers, adaptive optics, and support for individual investigators.
- Support for facilities will increase by $50.2 million, including increments of $32.1 million for ongoing construction of the Laser Interferometer Gravitational Wave Observatory (LIGO), $5 million for two 8-meter Optical/Infrared Telescopes, and $4.1 million for the National Astronomy Centers.
- Education and human resource programs will increase by 10 percent to a total of $43 million. Special emphasis will include curriculum development, support for undergraduates and faculty, and postdoctoral fellowships.

Social, Behavioral and Economic Sciences — $107.8 million — +25.5 percent

- The SBE Activity was established in FY 1992. Approximately 80 percent of SBE funds go to individual investigators.

- SBE will participate in the FCCSET Initiatives on Global Change (up $5 million) and Biotechnology (.6 million).
- More research opportunities will be provided for students primarily through increases in support for the Research Experiences for Undergraduates (REU) and the Research at Undergraduate Institutions (RUI) programs.

Education and Human Resources $479.5 million +3.1 percent

- EHR is requesting a year's rest from the spectacular growth of recent years. The Director suggested this is necessary to maintain effective management over burgeoning programs.
- Undergraduate education would increase to $63.0 million, or by 3.3 percent. Emphasis will be given to strengthening faculty at two-year colleges through coalitions of two-year and four-year colleges.
- Support for graduate education would be $57.9 million, a decrease of $20.5 million. This is due entirely to delay in funding the new graduate traineeships. Funds will be carried over from FY 1992, with no request for 1993 appropriations.
- EPSCoR,now in EHR, will receive $19.5 million, up $1.5 million.

Chapter 7

Health Research (HHS) in the FY 1993 Budget

National Association of State Universities and Land-Grant Colleges

Jerold Roschwalb

Highlights

- Total funding requested: $9,377 million, an increase of $443 million or 4.9 percent.
- $350 million of the increase is dedicated to Research Project Grants (RPG's). Nevertheless, new and competing grants decrease to 5,797 from 6,001, since increases allocated in advance to continuing grants require substantial funding. Total RPG's -- 22,129.
- Funding for most other NIH mechanisms are frozen at FY 1992 levels; effectively cuts 4.8 percent due to inflation (BRDPI).
- Special attention devoted to Women's Health and Minority Health studies.
- Over $600 million in funding to be delayed (about $525 million delayed in FY 1992) -- consequences not clear.
- ADAMHA total research funding rises to $1.121 billion -- an increase of 5.8 percent.

- ADAMHA treatment programs grow from $138.3 million to $260.3 million. Research grows from $571.7 million to $607.1 million. Most other mechanisms frozen.

Recent History

(For more details and analysis, please consult the Congressional Action on Research and Development in the FY 1992 Budget prepared by the R&D Budget and Policy Project of AAAS; page 28.) A report of the appropriations committee for the appropriations for FY 1992 reflects a positive environment with a typically supportive Congress increasing appropriations for NIH (and proportionately for ADAMHA). The salient number is an increase of 8.9 percent over FY 1991 ($8.277 billion/$8.936 billion). This figure also was a 2.7 percent increase over the Administration's request. In the FY 1992 budget, every line item or element of NIH research received some increase, whether it was 16 percent for cancer or 21 percent for the Genome project.

Special attention was given to the NIH director's office, as the source of funds for two new emphases, women's health and minorities' health. In addition, a new program of research grants to individual scientists -- the Shannon Awards -- would be funded out of the director's office as well. Finally, a program that has had much success in encouraging the enhancement of research in states that have been lagging behind the rest of the country in that area -- the so-called EPSCOR program -- was slated to begin in NIH as well. Again, from the office of the director.

The Shannon Awards operate as a form of bridge support for fine scientists whose applications had just missed the cut in the various institutes. The positive came bearing a negative: a 25 percent cap on indirect costs; a figure considerably lower in most instances than the rate established by the government on the host campus of those scientists. Nevertheless, none of the Shannon Awards have been rejected by an institution.

The FY 1992 appropriations bill carried with it new machinery -- new at least in emphasis: the delay of funding commitment. NIH was instructed to hold back funding of part of its FY 1992 funds until September 30, the last day of the fiscal year. There is much dispute over this approach. It is split essentially between those who say, as OMB officials do, that it is merely an accounting technique. No money will be lost. No projects will go unfunded.

Managing the Costs of Biomedical Research

The director of NIH in many public forums began to stress the term "opportunity" as the basis for management activity in the agency. Recognizing the realities of the fiscal situation and the paradoxical numbers of highly trained scientists prepared to conduct research, the argument was that stability and predictability were imperative to make the best use of federal funds Congress would appropriate.

NIH developed its plan based on the outline provided by the Congress. The key is the idea of "making optimal use" of limited federal resources through cost management and containment. In the Congress, the sense was that all mechanisms would be treated alike. The Administration this year has followed the theme that the support of individual investigators takes precedence. Important in this process is the Biomedical Research and Development Price Index (BRDPI). This measurement of inflation tends to show the costs in biomedical research to be about a point higher than the general inflation. NIH's FY 1980 funding was $3.4 billion. It grew to $7.6 billion in FY 1990. That equals 124 percent. Apply BRDPI, and the increase is 24 percent in that decade from $3.4 billion to $4.2 billion in constant dollars.

Using the decade of the 1980s, the average RPG has risen from $97,800 to $193,900, an increase of 98 percent. Apply BRDPI and the increase becomes 16 percent or $113,900. The concern over the rise in the average cost of grants stimulated some of this activity.

This figure of the average cost of the grant should also take into account the rapidly changing methodologies in medical research that have been possible only because of extremely costly equipment and facilities. When technology and the major influx of federal regulatory action that is also costly are taken into account, it could be argued that the average cost of an RPG has remained fairly stable in the past decade.

Indirect costs remain a concern. During the decade, there was a 24.9 percent increase in constant dollars compared to a 9.4 percent increase for direct costs in the same period. NIH charts show, however, that the major increase occurred in the first few years of the decade, and since 1984 the increases of indirect and direct are fairly comparable.

A matter of concern has been the average length of research grants. At the beginning of the decade, the figure was 3.3 years. At the end, it was 4.2 years. This led Congress to call for reducing the average to 4 years rather than let it creep up any longer. NIH, in quest of efficiency and the saving of paperwork, had been making grants for longer periods. This necessarily preempted dollars in the so-called "out years", leaving fewer dollars for new awards.

One major point for consideration lies in the area of "downward negotiations," a regrettable euphemism but directionally accurate. In this process, the applicant requests funding for a project and the initial review group makes a recommendation. Then another review group recommends a lower level. In FY 1980, the average cut was 3.2 percent. In FY 1990, it was estimated at 15 percent. This is in the competing area. In noncompeting, the two figures were 2.9 percent and 11.3 percent. Congress heard many complaints about the so-called downward negotiations. As they grew in size, they began to compel changes in the scope of the project and placed great demands on the host campus to find additional dollars to cover inexpendible elements of the research.

It is clear that the principal goals of the plan will be met whatever it takes to accomplish them. Discussion of how much the initial review groups cut from the application over the time period and how the amounts cut have changed in the past leads into the conclusion that members of the review groups will have to develop a heightened sensitivity to costs. No doubt there is validity in that, but it is a sea change from the original purpose of the peer review system in which peers evaluated the quality of science and its ability to be executed rather than focusing mightily on the dollar factor. If new cost control practices are needed, then that is something NIH is prepared to undertake. Were it not for the predetermined number of RPG's, the entire approach might seem less tendentious, but the number of grants is at the center of the plan.

During the past summer and autumn, NIH undertook to play a leadership role in dealing with the convoluted and arcane substance of indirect costs. Perhaps innocence undermined its efforts, since it based its approach on a study done by HHS staff that looked at indirect costs rates rather than the costs of doing research, a point repeatedly stressed by members of the director's own task force on the subject. The Director's Advisory Committee followed suit in its concern and may have left the indirect costs field to OMB and OSTP, where major study is now underway with the intent of rationalizing the system and finding approaches that Congress both understands and accepts and that are also fair to the universities that host most of the federal research.

Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA)

ADAMHA has a requested budget of $3.276 billion, a little more than a 6 percent increase over FY 1992. Only approximately one-third of the agency budget is committed to research. Roughly half of the agency budget is committed to treatment programs and about 10 percent is devoted to various prevention programs. ADAMHA, therefore, has a major difference from its sister agency, NIH. During this past year, legislation was introduced to transfer the research elements of the three subagencies -- mental health, drug abuse, and alcoholism -- to NIH as a separate institute with the treatment and prevention programs remaining as a separate agency. (NIMH actually started out on the NIH campus.) A transfer did not occur as intended as conflicts were not resolved. The issue remains on the agenda, though some believe that the passion for the transfer has cooled.

In the area of Research Project Grants (RPG's), the numbers reflect the entire funding activity. From FY 1991 to FY 1992 there was a moderate increase (2369/2432). The increase to FY 1993 (2479) is considerably less. More important, the major increase is in continuation grants (1714/1755) with barely an increase in the new/competing category (718/724). Research centers tell the same story an increase from 84 to 89 last year, a freeze at 89 this year. R&D contracts actually dropped from 176 to 167 last year, and they are at 168 this year.

Compare this with treatment programs: 201 in FY 1991, 188 last year, but up to 304 this year. Those are the numbers of pro-grams. The dollars for funding are comparable, rising from $138 million to $260 million.

Some reference numbers: the increase in dollars over last year for ADAMHA is $184.13 million. The increase in extramural research grants at NIMH is 6.3 percent and 14.8 percent for extramural research contracts. At NIDA, grants are increased by 6.4 percent and contracts by 3.9 percent. And in NIAAA, the increase in grants is 4.9 percent.

The mechanism charts show that at NIMH, RPG's increase from 1,240 to 1,269 in number and $289 million to $311 million. Centers and other related research are frozen at the FY 1992 level while intramural research grows from $96 million to $102 million. Training also is frozen at the same numbers and dollars as last year.

NIAAA continues the pattern. RPG's grow from 459 to 463, the smallest gain of the institutes. Centers are frozen while other related research actually drops in numbers and rises in dollars. Research training has some changes, but the totals remain the same in numbers and dollars. Intramural research grows from 20 to 22.

The National Institutes of Health

The Administration requests $9.38 billion for NIH for FY 1993. This is an increase of $443 million over FY 1992, an increase of approximately 5 percent. Consistent with its basic policy on priorities, the Administration directs $350 million of the increase to RPG's. Despite this, the number of new and competing awards drops from 6,001 for FY 1992 to 5,800 in FY 1993 because of the "out-year commitments" to the continuing grants that have commitments from NIH for small increases that consume most of the additional funds. The total number of RPG's, however, will reach a record 22,129. The policy of the Administration is that approximately 6,000 new and competing grants be made annually with a maximum of 24,000 for the four-year rotational period.

The mathematical inevitability of this distribution of dollars is that most of the mechanisms at NIH, including centers, training, and clinical trials, must be frozen for lack of additional funds. (The small but highly valued program, Biomedical Research Support Grants (BRSG), (once funded at about $60 million) was funded at $5.2 million last year, and the budget assumes that same number for FY 1993.) Because the Biomedical Research and Development Price Index (BRDPI) plays a major role in the thinking of the plan for managing costs, it is noteworthy that the increase of RPG's to a total of $5.277 billion is a 7.1 percent increase, while the increase for the agency as a whole (4.9 percent) is slightly under the BRDPI -- 5.08 percent. Consistent with Congressional interest and Administration policy, the budget gives special attention to the office of the director of NIH; continued funding of $10.2 million each for the Minority Programs (same as last year); $44.5 million to the Women's Health Study compared to $24.7 million last year, and $45 million for the new Minority Health Initiative. All of these are operated out of the director's office, though the NIH documents suggest that funds may be available from sources outside of that office.

The director's office will play a coordinating role in the Women's Health Study, which is essentially a clinical trial. Preventive measures are at the heart of the study, which views linkages of behavior, physiology, and other contributing factors. Reading the budget documents in conjunction with the congressional appropriations report explains some of the conundrum the agency finds itself in. The Congress does not want cuts across-the-board to achieve financial goals and wants downward negotiations eliminated. It calls upon the NIH "to play a more aggressive role in analyzing the reasons for cost increases, setting guidelines and policies about appropriate funding levels for certain type of expenditures." NIH responds in its submission to Congress that uniform across-the-board cuts are out, but it will continue to examine funding levels of grants after their initial review to eliminate inappropriate costs and to ponder "further reductions to meet the target number of grants intended by Congress." This is an issue that has been with us for some time. It involves more than mathematics and includes basic policy. How much of the real costs of a research project should be borne by the federal government, i.e., the taxpayer? If less than 100 percent, then who else is responsible -- industry, foundations, other private sources, the institution itself? This leads directly to some of the central questions in the current fracas over indirect costs. The past two years have provided some more definition of the questions, but it appears that we are still a long way from viable solutions.

FY 1992 Budget Policy

The budget submission indicates how the activity over indirect costs worked out fiscally. Congress set a ceiling of 26 percent of modified total direct research costs for administrative overhead. When it worked out the numbers for appropriation, it assumed a savings of $55 million because of this cap. There was also a provision that related the implementation of the cap to the beginning of an institution's fiscal year so only $24.2 million could be calculated as real savings for competing research project grants in FY 1992. The $30.8 million difference is viewed as an increase in competing RPG's in the FY 1993 budget.

Significant RPG figures for FY 1992 include 21,671 grants costing $4.93 billion. The funding level is 9 percent higher than in FY 1991 overall, with noncompeting rising by 5.8 percent and competing rising by 8.7 percent. The number of grants increased by 698 and competing awards by 230.

Funding for centers increased by 12.5 percent, and quantity of centers increased by 48 to 706 over FY 1991.

Contracts are funded at $644 million in FY 1992. While a comparatively small number in the agency, they have significant "news" value. For example, more than $2 million was assigned to develop a group B streptococcus vaccine, another $2 million went for the pertussis vaccine, $4.7 million went to the national vaccine program, $1.0 million for expanding the national bone marrow donor program, and so on. These are activities that are understood by most people.

Increasing attention in the FY 1992 budget went to prevention and control, much of it in the area of cancer. Prevention is almost certainly going to become increasingly emphasized over coming years.

FY 1993 Budget Policy

"Unprecedented opportunity" may be the byword for this year's substantive approach to the work of NIH this year. The investigator-initiated research project grant remains the highest priority and the primary mechanism for developing ideas that will improve the quality of life for American citizens and people around the world. That point of view meant that enough funds had to go to RPG's to provide 2 percent real growth over FY 1992. If the agency only receives 4.9 percent and the largest component, RPG's, receives a 7.1 percent increase, and you calculate the special issue programs (however small, including minorities, women's health, and specific disease concerns), you are left with a freeze on the rest of the agency. There are some who would place more attention on funding clinical trials, since they are the result of successful research ready to be field tested with the possibility of a new medication, surgical technique, or other treatment in the offing. Taking the information from the proverbial shelf to the clinic may be an issue that comes up in appropriations hearings this year.

With the freeze on most mechanisms, there is little to analyze. However, biotechnology raises interest. The document issued by the Administration this year made biotechnology one of five major science and technology initiatives for the country. The document notes $4.1 billion this year devoted to this discipline across more than a dozen agencies. NIH is cited as the major home for this activity, but initial perusal of budget documents fails to find very much new money. In the biotechnology research centers line, for example, the number of centers increases by 1 to 63, and the number of dollars increases from $39.6 million to $40.5 million. It is suggested that for this year's counting the Administration may have identified biotechnology research programs already funded and included them in the total. While the total may be accurate, the amount of new money does not appear to be very large.

Chapter 8
R&D in the Department of Energy

National Association of State Universities and
Land-Grant Colleges, Shamiram R. Feinglass

Energy Research Group, Ann Snell McNeil

Highlights

- The Department of Energy (DOE) proposes to spend $8,092 million on R&D in FY 1993, a decrease of 1.9 percent from the FY 1992 level.

- The Office of Energy Research (OER)--where 40 percent of DOE's R&D is funded--is slated for an 11 percent increase. Without the Superconducting Super Collider (SSC), funding for OER would increase by 7 percent. Under new leadership--DOE's own science and technology advisor--OER has initiated a cross-discipline, priority setting exercise that has begun to have budgetary impact.

- The fastest growing program within the DOE is Environmental Restoration and Waste Management, accounting for nearly a quarter of DOE's budget ($5,317 million). R&D in this area would decrease in FY 1993 to $223.2 million.

- Changes in world conditions and DOE's defense mission have prompted the first decrease in years for the Atomic Energy Defense Activities (AEDA) programs, where 37 percent of DOE R&D is funded.

The New Production Reactor and Uranium Enrichment programs are also slated to decrease.

- The Administration requests a 35 percent increase for the SSC. Of the $638.1 million requested, $470 million is for construction.

- Energy Conservation programs go up to $301 million, an increase of 26 percent, and the Clean Coal Technology program would see a 28 percent increase.

INTRODUCTION

The total budget for the Department of Energy (DOE) would increase by slightly more than 2 percent, while research and development within the agency would decrease by slightly less than 2 percent to $8,095 million. Most non-defense R&D is funded at or above FY 1992 levels, with university-based R&D receiving very modest increases.

Reflecting Administration-wide themes, DOE's FY 1993 R&D budget emphasizes technology transfer and development, as well as initiatives identified and coordinated through the Federal Coordinating Council on Science and Technology (FCCSET) process. These FCCSET initiatives include materials science, global warming, biotechnology, and high-performance computing. The DOE posture statement on the FY 1993 budget highlights $725 million for R&D related to implementation of the National Energy Strategy (NES), an increase of 16 percent over FY 1992 levels.

Under new leadership, the Office of Energy Research (OER) initiated a cross-discipline, priority setting exercise under the auspices of the Secretary of Energy Advisory Board Task Force on Energy Research priorities. The task force made preliminary recommendations to the new OER director and referred more specific priority items to the various scientific advisory boards, including the High Energy Physics Advisory Panel (HEPAP), the

Nuclear Science Advisory Committee (NSAC), and the Fusion Energy Advisory Committee (FEAC).

The task force's attention focused on capital projects planned in each discipline because of the projected impact these projects would have on OER's budget in future years. The SSC, an Administration initiative, was protected from the budget impact of these discussions. In the end, the fusion energy program lost its next experimental device, the Burning Plasma Experiment, in exchange for a less costly, advanced tokamak, and the high energy physics program received less than a one percent increase over last year's funding level.

Echoing a theme stressed by the Administration for other agencies which fund research--like the National Science Foundation and the National Institutes of Health--the DOE budget for FY 1993 emphasizes the importance of individual investigators. To support this initiative, DOE has set aside $40 million within OER for individual investigators. According to DOE, most of this funding is within the Basic Energy Sciences.

I. ENERGY SUPPLY RESEARCH AND DEVELOPMENT

The Department proposes to increase funding for Energy Supply Research and Development (ESRD) by 2.7 percent in FY 93 for a total of $2.1 billion. Nuclear R&D is reduced by 17.2 percent and Solar Energy R&D is up just barely to $175 million (+2.8 percent) from last year's funding level.

Solar and Other Renewables

Overall, the budget for Energy Supply R&D proposes to increase funding for Solar and Renewable Energy by 2.8 percent to $175.5 million. Photovoltaic Energy Systems would increase by 5.1 percent in this budget to $63.5 million; Wind Energy Systems would increase by 2.8 percent to $22 million. Funding for the Solar Energy Research Institute is reduced by 43 percent from $11.5 million to $6.5 million. The program area with the largest increase is Biofuels Energy Systems which would be up 23 percent to $48.4 million.

Nuclear Energy R&D

The Nuclear Energy R&D budget is down by 17.2 percent overall to $261.6 million, a significant change from the Administration's FY 92 submission, which proposed almost a 29 percent funding increase. Funding is just barely up for the Advanced Radio Isotope Power Systems from $51 million to $51.8 million but all other programs--with one exception--would receive less money in FY 93 than enacted in FY 92. The Light Water Reactor program would see a 6 percent decrease from $62.5 million to $58.7 million; the Advanced Reactor R&D program is decreased by 16 percent to $50 million (down from $59.5 million in FY 92).

The Space Exploration Initiative (SEI) is one of the only programs within the Nuclear Energy program that would receive an increase in FY 93, up to $10 million from $5 million. This initiative--which began in FY 92--is the DOE's contribution to the national initiative to return to the Moon and explore Mars. Key elements of the SEI program are nuclear propulsion, nuclear surface power, and critical technologies development.

Biological and Environmental Research

The FY 93 budget for Biological and Environmental Research--which is a program within the Office of Energy Research--is proposed to increase by 8.9 percent to $378.1 million. This program provides the scientific foundation for the health and environmental consequences of energy use and solutions for biomedical and environmental problems. A significant increase is in store for DOE's participation in the government-wide initiative on global climate change: funding for this program is up 47 percent, to $113 million.

Magnetic Fusion Energy

The Department continues to support the transition of fusion energy from a research program to a goal-oriented energy development program. The FY 93 request for fusion energy is up 6.3 percent from $329.5 million to $350.2 million. The program will focus this year on three major areas: U.S. participation in the International Thermonuclear Experiment Reactor (ITER); deuterium-tritium experiments on the Tokamak Fusion Test Reactor at the Princeton Plasma Physics Laboratory; and the development of a next-step fusion device to replace the Burning Plasma Experiment (BPX), which was eliminated from the program by DOE because of budget constraints. The fusion request includes $48 million for ITER and $20 million for work on the next machine.

Basic Energy Sciences

This is the largest program within the Office of Energy Research (OER). The request for BES programs is $805.5 million, 6.4 percent above last year's funding level. Over 22 percent of the BES budget is dedicated to the operation of major national research facilities. The largest element of the overall budget for construction is $110.4 million for the 6-7GeV Synchrotron Radiation Source (Argonne National Laboratory). Materials science research would increase almost 13 percent to $290 million under the DOE budget; chemical sciences would go from $158 million to $175 million (+11 percent); and advanced energy projects would take a significant cut (-78 percent) to $11.9 million from last year's funding level of $54.8 million.

II. FOSSIL ENERGY RESEARCH AND DEVELOPMENT

Fossil energy research and development is aimed at more effective and efficient use of fossil fuels, with coal research accounting for about 64 percent of the budget. Last year, Fossil Energy R&D was funded at $361.4 million. The Administration's FY 1993 request is $241.2 million, an overall decrease of 33 percent. Coal research and development--which includes a variety of technologies for promoting an environmentally sensitive approach to the use of coal--would be funded at $153 million, almost half last year's budget. DOE is restructuring the natural gas program to incorporate a "systems approach" and the agency requests $40 million for the refocused program, up considerably from last year's funding level of $12.6 million.

III. ENERGY CONSERVATION

These programs would increase by 25.9 percent to $301.1 million for FY 1993, which represents over a twofold increase since FY 1989 when DOE renewed efforts in this area. Energy conservation is a primary objective of the National Energy Strategy, and the Administration views the increase for FY 1993 as an illustration of an aggressive R&D program to promote promising technologies for improving energy end-use efficiency. The goals of this program involve diversifying fuel sources, using indigenous resources, and reducing America's vulnerability to energy supply disruptions.

The current request for **Building Technologies** is $38.8 million, an increase of 7 percent, and continues support for solar cooling systems R&D, and initiates a new program that would focus on research to develop energy efficient replacements for ozone-destroying chlorofluorocarbons (CFC). **Industrial Technologies** increases by 9 percent to $93 million with a focus on decreasing industry's dependence on oil by developing alternate energy technologies as well as attempts to mitigate disposal problems associated with waste. As was the case last year, the largest increase in this account is in the **Transportation Technologies** which shows a 50 percent increase to $151 million. The goal of this program is to increase fuel saving through advanced technologies, including development of a new generation of batteries through the U.S. Advanced Battery Consortium (funded at $41.5 million) and, in collaboration with US autoworkers, to develop and introduce electric hybrid vehicles into the market ($20 million).

IV. GENERAL SCIENCE

General Science programs account for almost 50 percent of OER's budget. These programs include High Energy Physics, the Superconducting Super Collider (SSC) and Nuclear Physics programs. Overall, there is a 12.2 percent increase in funding for R&D in the General Science program.

High Energy Physics

The High Energy Physics (HEP) program is aimed at understanding the nature of matter and energy at the most fundamental levels. The budget proposed for HEP is 360.9 million, one-half of one percent above FY 1992's funding level. The HEP program calls for continued research at the Tevatron (Fermilab), Stanford Linear Accelerator, and the Brookhaven Alternating Gradient Synchrotron. The request includes $30 million for the construction of the Fermilab Main Injector. Advanced accelerator and detector R&D related to the next generation of high energy particle accelerators is also supported in the budget. A new category, the SSC Lab Research program, is slated to receive $2.5 million.

Superconducting Super Collider

The largest increase in the General Science program is for the SSC, which increases by 35 percent to $638.1 million in FY 1993, of which $470 million is for construction. This is in accordance with the cost and schedule baseline adopted for the project by DOE. The Administration envisions the SSC as an "initiative to strengthen the position of the Nation as a world leader in science and technology." As has been the case in the past years, the SSC remains a controversial project that has revived a long-standing debate in the science community on issues associated with large user facilities, sometimes called "big" science. The debate was fueled during OER's priority-setting deliberations--where the SSC was held harmless--and again after the Administration failed to secure a firm financial commitment for the project from the Japanese.

The SSC R&D funds in FY 1993 will provide for continued testing and fabrication of primary magnets, design and testing of secondary magnets, and other collider technical systems. Construction funding will be used for a magnet industrialization program, technical systems fabrication and on-site construction of conventional facilities.

Nuclear Physics

Nuclear Physics programs increase by 2.6 percent to $363.5 million in FY 1993. The nuclear physics program is divided into four areas: medium energy physics, high intensity physics, low energy physics, and nuclear theory. The program supports researchers in conducting experiments at facilities here and around the world. Funding levels will allow for the continued construction of two large construction projects, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Lab and the Continuous Electron Beam Accelerator Facility (CEBAF). The Administration proposes to terminate the Holyfield Heavy Ion Research Facility at Oak Ridge National Lab and the fast Neutron Generator at Argonne National Lab; DOE also proposes to phase-out the Bevelac facility at Lawrence Berkeley Lab and the Los Alamos Meson Physics Facility (LAMPH) at Los Alamos National Lab after FY 1993.

V. ATOMIC ENERGY DEFENSE ACTIVITIES

In addition to providing for R&D and engineering for U.S. nuclear weapons, the AEDA account provides for maintenance and restoration of the nuclear weapons complex. AEDA still claims the largest portion--37 percent in FY 1993--of the DOE R&D budget. As a result of arms reduction initiatives and the changing defense climate, funding for AEDA would be reduced by 11.3 percent to $2,968.8 million for FY 1993. The most dramatic reduction in the AEDA budget is in the **New Production Reactor (NPR)** program, which is slated to be cut by 75.6 percent to $108.9 million. Anticipating a decreased demand for tritium, DOE has decided that it is no longer necessary to build the NPR on an "urgent schedule" and has delayed the NPR technology and siting decisions for two years.

VI. URANIUM ENRICHMENT

The chief goal of this program is to develop a cost-effective and advanced production technology to enrich uranium through the Uranium-Atomic Vapor Laser Isotope Separation process (UAVLIS). In the long term, the Administration would like to privatize the technology, and DOE supports legislative efforts to create a temporary government corporation. DOE proposes $100 million for the program in FY 1993, a reduction of 38.9 percent. Included in the request are funds to complete the plant-scale demonstration; however, the request does not include funds for activities which would lead to the deployment of an UAVLIS production plant.

VII. CLEAN COAL TECHNOLOGY

The Clean Coal Technology Program is a demonstration program which was started in 1986 to design technologies to improve the efficiencies of coal-burning plants. Currently there are 32 projects which have cooperative agreements; 10 additional projects are under negotiation. Industry is required to cost-share at least 50 percent of the project costs. DOE requests $500 million in the FY 93 budget for the clean coal technology program, up almost 30 percent from the FY 92 enacted level of $390 million.

VIII. ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

Although this is the fastest growing program area in the Department, commanding a quarter of the overall DOE budget, Environmental Restoration and Waste Management R&D has taken a 0.3 percent cut (to be funded at $223.2 million for FY 1993). DOE says they are focusing on the immediate characterization of waste sites and expect to fund R&D in the area of Environmental

Restoration and Waste Management at a higher level in future years.

Chapter 9

NASA in the FY 1993 Budget

American Institute of Aeronautics and Astronautics

Joanne Padron

Highlights

- The proposed FY 1993 budget for NASA is $14.993 billion, an increase of $640.2 million. Research and Development was increased 13 percent for a total request of $7.73 billion in FY 1993. This represents half of NASA's total budget request.

- Space Station Freedom was increased $221 million to $2.25 billion in FY 1993. The space station program underwent a major battle to cancel last fiscal year and is expected to be the hot issue again this fiscal year.

- The Administration cancelled two major programs: The Advanced Solid Rocket Motor (ASRM) program and Comet Rendezvous Asteroid Flyby mission. Cancellation of both these programs is expected to cause much serious discussion in Congress.

- The National Aerospace Plane (NASP) program received a major increase (300 percent), up $60 million to $80 million.

- The Space Exploration Initiative (SEI) has been assigned a separate budget statement now that the Office of Exploration has been resurrected. The request for SEI funding is modest, only $31.8 million in FY 1993.

Proposed FY 1993 NASA Budget

The proposed NASA budget for FY 1993 is $14.993 billion, an increase of $640.2 million above the FY 1992 current estimate of $14.352 billion. This represents an increase of 4.5 percent, a far cry from the 23 percent requested in FY 1991.

The biggest increases in the NASA budget occurred in the following two categories:

- Research and Development -- from $6.85 billion in FY 1992 to $7.73 billion in FY 1993, an increase of $880 million (13 percent), and
- Inspector General -- from $14.6 million in FY 1992 to $15.9 million in FY 1993, an increase of $1.3 million.

The biggest decreases in the NASA budget occurred in the following two categories:

- Construction of Facilities -- from $525 million in FY 1992 to $319.2 million in FY 1993, a decrease of 40 percent, and
- Space Flight, Control and Data Communications -- from $5.385 billion in FY 1992 to $5.267 billion, a decrease of 2 percent. This area is concerned with Shuttle production and operational support and provides tracking and communication systems required for all NASA flight projects. This category has generally been favored with increases in the past.

Although this category is not a part of research and development, it should be noted that the Advanced Solid Rocket Motor (ASRM) program was eliminated from the Administration's request in Space Flight, Control and Data Communications. The ASRM program is being conducted mainly in the district of Rep. Jamie Whitten

(D-MS), the chairman of the House Appropriations Committee. There has been much speculation that Rep. Whitten will take great issue with this deletion and look towards NASA's research and development programs for ways to save ASRM.

The rest of this chapter will restrict itself to an analysis of NASA's Research and Development budget.

Research and Development

NASA's program of research and development is concerned with "extending our knowledge of the Earth, its space environment, and the universe; expanding the technology for practical applications of space technology; to develop and improve manned and unmanned space vehicles; and to assure continued development of the long-term aeronautics and space research and technology necessary to accomplish national goals."

NASA's research and development program is broken into the following ten elements:

Space Station Freedom

Once again Space Station Freedom remained at the top of the list of controversial programs. In fiscal year 1992 the Administration requested $2.029 billion to continue support of station development. After being trimmed down by the authorization subcommittees, the program was completely eliminated by the House VA, HUD and Independent Agencies' subcommittee on appropriations. A floor debate followed to save the beleaguered project, and funds were reinstated for the exact amount requested by the Administration.

The FY 1993 funding requested is for $2.25 billion, an increase of 11 percent over FY 1992. As of this writing, it is not expected that the program will be completely deleted upfront by either the authorization or appropriation subcommittees. However, it is expected that a heated debate over the merits of the program will occur. There are many people in the space science community who feel that the restructured station will not be able to carry out the life science and microgravity missions it is touted to be able to support. This sentiment, coupled with the extremely small increase requested for NASA this fiscal year and the small increases expected in years to come, will make the station a prime target for the congressional axe.

In FY 1993 Space Station Freedom will complete its project level Critical Design Review (CDR) and begin its system level CDR. First element launch is scheduled for fiscal year 1996, with man-tended capability (MTC) scheduled in FY 1997 and permanent manned capability (PMC) in FY 2000.

Space Transportation Capability Development

This area received an increase of 18 percent, growing from $731.45 million in FY 1992 to $863.7 million in FY 1993. The largest increase went to the New Launch System (NLS) program, a joint NASA/DOD project. The NLS program is in response to NASA's efforts to "develop a new evolutionary unmanned (but man-rateable) launch system." NASA expects NLS to support future space exploration missions as well as provide operational support to Space Station Freedom. The FY 1993 request is $125 million, an increase of 229 percent over FY 1992.

However, NLS has struggled to maintain congressional support. In fiscal year 1992 the Administration requested $175 million for the program, and Congress only approved $38 million. Given the fact that neither NASA nor DOD can show any current pressing need for a new launch vehicle, and since it will be unable to assist in the construction of Space Station Freedom, Congress may again trim the program down to a minimal amount.

Advanced Programs received the second largest increase in this category, from $39.3 million to $57.7 million in fiscal year 1993 (47 percent). The Advanced Programs are designed to conduct definition studies to support new developments, system improvements, and expanded capabilities for space transportation systems.

Space Science and Applications

Funding requested in this area was increased $269.2 million (10 percent) to $2.985 billion. The Space Science and Applications program is divided into seven subcategories:

- Physics and Astronomy -- increased $66.2 million to $1.114 billion (6 percent). Almost 40 percent ($440.9 million) of the request goes to Mission Operations and Data Analysis. This program is designed to support operations, servicing, and data analysis of physics and astronomy spacecraft. $214.2 million of Mission Operations and Data Analysis will go to the first planned servicing mission of the Hubble Space Telescope, scheduled for 1993 to place an optical correction instrument on the blurred spacecraft.

- Life Sciences -- increased from $145.8 million in FY 1992 to $177.2 million in FY 1993. This includes $18.4 million (an increase of $10.2 million) for an integrated Centrifuge facility onboard Space Station Freedom. This item had been eliminated last fiscal year during the restructuring of the station and was replaced under pressure from the science community, most notably the National Academy of Sciences.

  All life science projects related to Space Station Freedom have been budgeted under the Space Biological Sciences program. This area was increased 25 percent to $18.3 million (not including the Centrifuge).

- Planetary Exploration -- decreased 9 percent, from $535.6 million to $487.2 million. The most notable change is the Administration's request to terminate the Comet Rendezvous Asteroid Flyby (CRAF) project from the joint CRAF/Cassini mission. Cancelling CRAF is estimated to save $200-$250 million. However, terminating CRAF may not necessarily save the Cassini mission. Cassini has increased its costs by $270 million for an estimated total cost of $1.68 billion. In addition, the launch date has slipped 15 months to mid-1997 because of budget cuts.

Included in the budget request for Planetary Exploration is $7 million to begin a third mapping cycle for the Magellan spacecraft. Magellan has already completed one round of mapping the Venusian surface and is in the process of finishing its second. There has been some discussion in Congress to delete further support for the spacecraft, since it will have completed its mission in FY 1992 and there is no pressing need to extend its operations.

- Earth Science -- was increased $130 million to $868.5 million in FY 1993. Over one-third of the request will go to the Earth Observing System (EOS), a series of satellite instruments designed to obtain long-term measurements of various aspects of the Earth's environment. EOS was restructured last fiscal year from the large polar-orbiting platforms program to a smaller mission series program. The restructuring of EOS was due to recommendations from an External Engineering Review team and Congress. The new EOS mission will now fly instruments solely designed to study global climate change.

  The impact of humans on the Earth's environment has become an increasingly prominent issue around the world. NASA recently released a study which showed the ozone layer depleting at a much faster rate than anticipated. These findings will likely encourage Congress to support the Administration's request of $308.4 million for EOS as much as possible.

- Materials Processing in Space -- increased 64 percent to $195.3 million. Two-thirds of the request went to Materials Experiment Operations, which supports Shuttle, Spacelab and cargo-bay experiments. A portion of the Administration's FY 1993 request of $129.1 million in this area will go toward the development of the United

States Microgravity Payload (USMP-1) mission and the United States Microgravity Laboratory (USML-1).

The largest increase went to Space Station Utilization, growing 152 percent to $19.3 million. Funding in this area during fiscal year 1993 will go toward the development of the Advanced Protein Crystal Growth Facility and the Space Station Furnace Facility.

- Communications -- decreased almost $8 million (63 percent) to $4.6 million in FY 1993. Much of this decrease is due to the fact that Advanced Communications Research was transferred to Aeronautics and Space Research Technology and that Radio Science and Support Studies was transferred to Commercial Use of Space.

  Another reason for the sharp decline in funding for Communications is the decrease in funding for the Advanced Communications Technology Satellite (ACTS). ACTS funding was decreased from $11.2 million in FY 1992 to $3.6 million in FY 1993. This decrease is due to winding down the project that is slated for launch in early 1993.

- Information Systems -- increased 16 percent to $40.7 million.

- Research and Operations Support -- increased $15.7 million to $98 million in fiscal year 1993.

Commercial Programs

Commercial Programs received a 15 percent increase from the Administration in FY 1993, growing from $148.6 million to $171.6 million. Commercial Programs is separated into two subcategories:

- Technology Utilization -- decreased $0.8 million (2.5 percent) to $31.7 million. This subcategory is set up to assist the transfer and application of aerospace technology to the public and private sector.

- Commercial Use of Space -- increased 20 percent to $139.9 million in FY 1993. The largest portion of this program goes to Commercial Transportation, which received an increase of 30 percent for a total request of $76.9 million. $51.4 million of this request will go toward the Commercial Middeck Augmentation module. In addition, funding will support continuation of the Commercial Experiment Transporter (COMET) program, which will provide long-duration exposure for microgravity payloads.

Aeronautics and Space Research and Technology

Requested funding in this area increased from $1.104 billion to $1.302 billion (18 percent) in fiscal year 1993. This area is divided into three subcategories:

- Aeronautics Research and Technology -- increased $115.6 million (15 percent) to $890.2 million. Systems Technology Programs received the biggest boost, growing 24 percent to $253 million. This program includes the multi-agency project, High-Performance Computing and Communications (HPCC), created last year. Funding for HPCC doubled in FY 1993 to $35 million. The largest increase in Systems Technology Programs went to Advanced Subsonic Technology, which grew from $5 million in FY 1992 to $12.3 million in FY 1993. A portion of this request will go toward aging aircraft research and development.

  High-Speed Research was increased by $18.3 million to $89.9 million. The High-Speed Research Program is scheduled to submit an assessment of the atmospheric effects of stratospheric aircraft to the National Academy of Sciences in FY 1993. The funds budgeted for this program over the years have been used primarily to address environmental issues before technology development is pursued.

- Transatmospheric Research and Technology -- increased 300 percent, growing from $20 million to $80 million in FY 1993. This significant increase reflects the Administrations push to pursue the joint NASA/DOD National Aerospace Plane (NASP) program. The budget request is slated to enable the program to move from Phase 2 to Phase 3, the construction and flight test of a test vehicle.

- Space Research and Technology -- increased $23 million to $332 million in FY 1993. The goal of this area is to provide advanced, enabling technologies for future space missions. Space Research and Technology has seen much change over the last year. The funding for Exploration Mission Studies program has been transferred to the new Space Exploration category and is discussed later in this chapter.

  In addition, the Exploration Technology Program and Space Automation and Telerobotics Program have been transferred into the Civil Space Technology Initiative (CSTI) program, which explains its near doubling from $79.8 million to $158.2 million in FY 1993. The CSTI program has been restructured to focus on five elements: space science, planetary surface, transportation, space platforms, and operations.

Space Exploration

In FY 1991 NASA initiated an Outreach Program, which was chartered to formulate exploration architecture options and assess enabling technologies for the Space Exploration Initiative (SEI). A Synthesis Group was formed to integrate the results of the Outreach and provide recommendations to NASA. One of the recommendations was to recreate the Office of Exploration, which had been moved to the

Office of Aeronautics, Space and Technology. Funding for any SEI-related programs had previously been placed under Space Research and Technology.

With the resurrection of the Office of Exploration and the creation of a separate budget statement comes an extremely modest request of $31.8 million for FY 1993. With the increasing deficit, restrictions on domestic discretionary funding and debates over the merits of large programs such as the space station, SEI has not been embraced by Congress with the enthusiasm that the Apollo program enjoyed. The majority of the request ($28.8 million) will go toward the development of small-scale precursor missions to the moon. The remaining amount will cover conceptual mission studies for SEI. It is expected that the appropriation subcommittees will not look favorably upon an ambitious program such as SEI, regardless of its modest start.

Safety, Reliability and Quality Assurance

This area declined 3 percent, going from $33.6 million in FY 1992 to $32.5 million in FY 1993. The program's objective is "to assure the safety and quality of NASA missions." Elements of the program include developing technical standards, demonstrating key technologies, system analyses, and quality assurance.

Academic Programs

The request for NASA's Academic Programs was increased 7 percent, growing from $66.8 million to $71.4 million. With the release of the National Education Strategy, "America 2000," NASA has stepped up its activity in this area. Academic Programs is broken down into three areas: 1) Educational Affairs, which received a request of $33.7 million; 2) Minority University Research and Education, which received a request of $22.7 million; and 3) Space Grant College and Fellowships, which received a request of $15 million.

Tracking and Data Advanced Systems

This area increased $1.2 million for a total request of $23.3 million in FY 1993. The funding request will go toward the Advanced Systems Program, which is designed "to improve the performance, capability, and reliability of future space missions in the critical areas of communications, navigation, and mission operations."

Chapter 10

R&D in the Department of Agriculture

National Association of State Universities and
Land-Grant Colleges

James W. Cowan, Elizabeth Allred

Highlights

- New Uses for Agricultural Commodities ($117.9 million, an increase of $17.8 million)
- Biofuels ($14.7 million, an increase of $9.2 million)
- Nutrition ($56.2 million, an increase of $4.8 million)
- Food Safety ($44.8 million, a decrease of $0.6 million)
- Water Quality ($80.6 million, an increase of $0.2 million)
- National Research Initiative ($150.0 million, an increase of $52.5 million)
- Global Change ($47.6 million, an increase of $3.3 million)

The total budget proposed for USDA is $59.4 billion, with a little more than $1.3 billion of that amount proposed for research and development. This represents a $9.9 million increase over the current estimate for fiscal year 1992 and a $91 million increase over fiscal year 1991. The research and development activity of USDA is housed in the Agricultural Research Service (ARS), the Cooperative State Research Service (CSRS), the Economic Research Service (ERS) and the Forest Service (FS). The funding levels for R&D by agency for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
Ag'l Research Service (ARS)	606.3	642.6	668.4
Coop. State Research Service (CSRS)	372.7	415.1	407.9
Economic Research Service (ERS)	54.8	59.1	60.8
Forest Service (FS)	186.0	184.1	173.7
Total R&D	1,219.8	1,300.9	1,310.8

New Uses for Agricultural Commodities

Departmentwide efforts are underway to promote new uses for agricultural commodities. New opportunities exist to deal with environmental and other societal concerns through the development of agriculture-based industrial and consumer products. Value-added products developed through research can greatly enhance the competitiveness of the United States in international markets, increase farm income and reduce farm program costs, increase employment and provide new economic opportunities for rural residents. New uses for agricultural commodities include totally biodegradable plastics, biopesticides manufactured from starch, industrial lubricants and coatings and natural additives for foods. This effort also includes the Alternative Agricultural Research and Commercialization (AARC) which was initially funded in fiscal year 1992 at $4.5 million. AARC seeks to supply new, value-added products on the international market to meet consumer and industrial needs. This endeavor, conducted through the AARC Center, can, among other things, reduce the use of nonrenewable and imported raw materials and improve the United States' balance of trade. The funding levels for R&D for New Uses for Agricultural Commodities for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
ARS	60.5	65.9	71.8
AARC	0.0	4.5	10.0
CSRS	15.3	19.7	26.7
ERS	0.1	0.1	0.1
FS	7.5	9.3	8.7
Nat'l Ag Library	0.6	0.6	0.6
Total	84.0	100.1	117.9

Biofuels

With increasing concern for clean air and a national energy strategy, the USDA budget proposes a major R&D initiative on a departmentwide basis, with some programs coordinated with the Department of Energy, for biofuels research to answer the demand for new sources of fuel. Agriculture-based fuels, such as ethanol and biodiesel substitutes, respond to environmental concerns but also will increase demand for commodities and improve farm income, lower farm program costs, improve the nation's energy security and enhance the balance of payments. The funding levels for R&D for Biofuels for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
ARS	1.4	3.4	7.7
CSRS	0.8	0.8	5.7
ERS	0.4	1.1	1.1
FS	0.1	0.2	0.2
Total	2.7	5.5	14.7

Nutrition

Another major initiative in USDA's fiscal year 1993 budget proposal is Nutrition Education which includes proposals for increased funding of nutrition research. Funding for continued research to study the relationships between diet and health is proposed. Expanded research is projected which would determine the nutrient and food components that may reduce chronic disease risk; examine nutrient functions to define nutritional status; and define important mineral functions and nutrient interactions. The funding levels for R&D for Nutrition for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
ARS	41.7	41.9	47.1
CSRS	6.1	7.5	7.1
Human Nutrition Info Service	1.9	2.0	2.0
Total	49.7	51.4	56.2

Food Safety

Food Safety continues as a USDA initiative, introduced as such in fiscal year 1991. Another departmentwide effort, this emphasis includes research such as the physical causes and economic consequences of food safety risks; development of improved techniques for rapid pesticide residue detection; and new production systems and processes to control salmonella and other microbiological contaminants. The funding levels for R&D for Food Safety for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
ARS	32.9	36.0	36.4
CSRS	7.9	8.8	7.1
ERS	0.6	0.6	1.3
Total	41.3	45.4	44.8

Water Quality

Water Quality research programs remain an area of emphasis in USDA's budget. One aim for fiscal year 1993 is to complete research on the Midwest Corn Belt on the use of nitrogen and pesticides in connection with conservation tillage practice in corn and soybean production. Data collection and analysis which includes funding for the pesticide use survey is proposed for continued funding. Other research activities include: assessment of role of wetlands and stream border in modifying the movement of chemicals into water; development of crop rotation systems and means to use animal wastes to maintain and improve water quality without sacrificing profitability; and improvement of understanding of transport and deposit of agricultural chemicals in soils and water. The funding levels for R&D for Water Quality for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
ARS	42.5	45.7	46.2
CSRS	32.9	32.9	32.6
ERS	1.8	1.8	1.8
FS	0.1	0.0	0.0
Total	77.3	80.4	80.6

National Research Initiative (NRI)

The National Research Initiative (NRI) continues to attract high quality research proposals from a broad group of scientists and allows for increased federal funding of agricultural research by institutions other than ARS. The NRI is recommended for funding in fiscal year 1993 at a level of $150 million, representing a $52.5 million increase over fiscal year 1992. A competitive grants program, proposed funding for the NRI for fiscal year 1993 would embrace departmentwide initiatives such as biofuels ($5.7 million), water quality ($5.6 million), global change ($10.4 million), human nutrition ($8 million) and new uses for agricultural products ($18.3 million). Ongoing research activities include: genome mapping which forms the basis for enhanced genetic engineering of plants by identifying the locations of economically important genes on chromosomes; industrial development of value-added or new products; dietary patterns; and rural community and economic development issues. The funding levels for the six areas of the NRI for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
Natural Resources and Environment	14.0	18.0	28.0
Nutrition, Food Quality & Health	4.0	6.5	17.0
Plant Systems	35.0	40.0	52.0
Animal Systems	20.0	25.0	32.0
Processes and New Products	0.0	4.0	16.0
Markets, Trade and Policy	0.0	4.0	5.0
Total	73.0	97.5	150.0

Global Change

Global Change remains a concern of USDA and an overall increase in funding is recommended. Research will continue its focus in atmospheric carbon dioxide, methane and nitrous oxides from forest land conversion; livestock and rice production; and the application of chemical nitrogen fertilizers. Concern persists on shifting temperature and moisture patterns which have significant implications for agriculture and forestry. So that informed decisions can be made which affect the supply of food and fiber, emphasis will be placed on better understanding the basic processes of carbon and nutrient cycling, climate and hydrologic cycles and soil formation. The funding levels for Global Change for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
ARS	5.1	7.1	9.3
CSRS	9.6	11.6	13.4
ERS	0.0	0.8	0.7
FS	22.7	23.3	22.7
SCS	1.5	1.5	1.5
Total	38.9	44.3	47.6

USDA Agencies

Agriculture Research Service (ARS) -- ARS, the primary research agency of USDA, conducts basic and applied research at federal laboratories. Its research efforts include all departmentwide initiatives described above as well as efficient food and fiber production and other natural resource concerns of agriculture, food and the development of new products. The funding levels for ARS for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
Soil and Water Conservation	73.0	82.0	82.9
Plant Sciences	232.7	244.8	252.0
Animal Sciences	107.8	112.5	114.0
Commodity Conversion/ Delivery	121.0	127.4	138.2
Human Nutrition	48.3	49.9	55.1
Integration of Ag'l Systems	23.5	26.0	26.2
Total	606.3	642.6	668.4

Cooperative State Research Service (CSRS) -- CSRS administers federal funds on a formula basis (Hatch Act, 1890 institutions, forestry) which are provided for research at the state agricultural experiment stations and other eligible institutions. CSRS also administers the National Research Initiative as well as other competitive grants and special research grants programs. The agency also participates in the nationwide system of research planning and coordination. The funding levels for the various research programs in CSRS for fiscal years 1991 and 1992 and the proposed levels for fiscal year 1993 are as follows (in millions of dollars):

	1991 Actual	1992 Current Estimate	1993 President's Request
Hatch Act	162.3	168.8	168.8
1890 Colleges and Tuskegee	26.3	27.4	28.4
Forestry	17.9	18.5	15.8
1890 Capacity Bldg Grants	8.2	10.2	11.5
Critical Ag Mat.	0.8	0.4	0.0

Special Research Grants	23.8	47.1	28.9
NRI	73.0	97.5	150.0
Animal Health	5.5	5.5	0.0
Alternative Crops Research	1.2	1.2	0.0
Sustainable Ag	6.7	6.7	4.5
Int'l Trade Ctrs	3.1	0.0	0.0
State Ag Weather Info System	0.0	0.4	0.0
Special National/Other Research Grants			
IPM	4.0	4.5	5.0
Pest. Clearance	3.0	3.5	7.0
Pesticide Impact Assessment	3.0	3.0	3.0
Minor Use Animal Drugs	0.4	0.4	0.6
Biological Impact Assessment	0.3	0.3	0.3
Rural Dev Ctrs	0.5	0.5	0.0
Aquaculture	0.6	0.3	0.0
Tropical/Subtropical Agriculture	3.3	3.3	0.0
Water Quality	8.0	9.0	9.0
Global Change	0.0	2.0	4.0
Rangeland	0.5	0.5	0.0
Aquaculture Ctrs	3.7	4.0	0.0

Economic Research Service (ERS) -- ERS performs economic and other social science research, outlook forecasting and policy analysis related to U.S. and international agriculture, food, production resources and rural America. The fiscal year 1993 budget request for $60.8 million represents a $1.7 million increase over the fiscal year 1992 current estimate level of $59.1 million. ERS was funded at $54.8 million in fiscal year 1991. The fiscal year 1993 budget request proposes the following increases: $3.65 million for Pesticide Data Program, up from $1.1 million in fiscal year 1992; $0.4 million increase for economic evaluation of nutrition activities in support of the Department's Nutrition Education Initiative.

Forest Service (FS) -- Research in FS is conducted and disseminated through eight regional forest experiment stations and the Forest Products Laboratory and includes both in-house and extramural programs. The fiscal year 1993 budget request for $173.7 million represents a decrease from the current estimate for fiscal year 1992 of $184.1 million. Within this reduction, only small increases are available for research in wetlands, forest health monitoring, recycling, enhancing rural America and tropical forestry. The Global Change research component in FS is recommended for a three percent reduction over the 1992 level, receiving a recommendation for $22.7 million.

Chapter 11

R&D in the Environmental Protection Agency

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Highlights

- The Environmental Protection Agency (EPA) has requested a 5.3 percent increase for R&D in FY 1993, bringing the total to $528.4 million (see Table II-16). However, after adjusting for inflation, EPA would provide 10.8 percent less for the conduct of R&D than in FY 1980.

- The President's budget assumes $350.0 million (up 4.2 percent) for extramural R&D, and $178.4 million (up 7.4 percent) for intramural research. The intramural request assumes a 7.7 percent increase for salaries and expenses to add scientists and engineers for in-house R&D and management of extramural research, and a 6.8 percent increase to upgrade obsolete facilities and equipment.

- Interdisciplinary and interagency programs account for a growing share of EPA's R&D. The agency would contribute a total of $66.6 million for the five Presidential initiatives in science and technology. Other cross-cutting issues include pollution prevention, risk assessment, lead abatement, and groundwater research.

- The increasingly cross-media character of the EPA program is reflected in the 11.2 percent increase proposed for multimedia research, which at $170.8 million would account for nearly a third of EPA's R&D budget.

- Among the media-related research programs, radiation, acid deposition, and global change are slated for double digit increases, with slower growth proposed for most others. The major exception is hazardous waste (down 12.0 percent after adjusting for bookkeeping changes).

- Many programmatic decreases (e.g., hazardous waste) reflect Administration opposition to the rising levels of earmarked funding. The budget would discontinue all but $4.0 million of the $33.4 million for projects itemized by Congress in FY 1992, which accounted for 8.5 percent of the R&D appropriation, up from 4.4 percent in FY 1990.

Multimedia R&D

The agency would provide an increase of 11.2 percent to $170.8 million for multimedia programs that support cross-media issues, technology transfer, quality assurance and control, and inhouse research capabilities. EPA is moving toward "clustering" of activities, by comparison to the industry-specific and issue-specific approach it has used in the past. Programs designed to develop generic capabilities, determine and reduce risks, and prevent pollution would be highlighted in the multimedia area.

By far the largest increase is proposed to bring Environmental Monitoring and Assessment Program (EMAP) support up 72.5 percent to $45.0 million. EMAP would continue long-term efforts to expand capabilities to assess ecological systems, and explore the effect of human activities on our environment, while dealing with site-specific environmental questions in the near term. Increases would support pilot and demonstration projects across the nation, in ecosystems as diverse as agroecosystems, forests, lakes, prairie potholes, salt marshes, and wetlands. Specific projects tied to EPA geographic initiatives are planned in the Great Lakes and Gulf of Mexico regions.

Four multimedia programs provide for generic risk assessment and human exposure research. Support for these programs (and ecological risk assessment activities moved to EMAP) would grow 1.7 percent to $20.4 million. The agency plans to perform research designed to reduce the uncertainty inherent in assessing risks to both human health and the environment, promote consistent risk assessment methodology, and validate sampling techniques for human exposure determination.

Multimedia's contribution to pollution prevention research would decline 9.1 percent to $5.0 million. However, support for projects, other than the congressionally directed efforts marked for termination, would be increased. Pollution prevention research activities throughout EPA are slated to rise about 2 percent to $12.6 million. The multimedia program would continue to target specific pollution problems, as well as cross-cutting research. The agency also is planning to continue research to reduce pollution from greenhouse gases, hazardous air pollutants, and organic solvents. Support for risk assessments of advanced materials would be provided to the Presidential Initiative in Advanced Materials and Processing. Socioeconomic studies concerning incentives for pollution prevention activities would be provided through a separate $0.8 million effort.

EPA supports considerable extramural research through exploratory research grants and academic research centers. The programs would be funded at a level of $27.5 million, 2.1 percent lower than this fiscal year. During FY 1993, 76 new grants, 104 ongoing grants, and five centers are intended. This is twelve fewer grants than are anticipated this year, and a smaller number of larger centers that would address airborne organics, ecotoxicity, clean manufacturing, and marine ecosystem issues. EPA also plans to continue the visiting scientists programs, providing for the summer placement of ten fellows in EPA laboratories.

Programs for outreach, and for information and technology transfer would grow 4.6 percent to $7.6 million. The quality assurance program is slated to increase 7.1 percent to $1.8 million. Support for laboratory, field, and headquarters expenses would increase 13.2 percent to $48.1 million. A particular increase of $2.8 million would bring the commitment to replace outdated scientific instrumentation to $13.6 million. Finally, $4.5 million for the multimedia lead program and $6.5 million for the EPA portion of the interagency High Performance Computing and Communications initiative would be increases of 81.8 percent and 78.9 percent, respectively.

Air Quality R&D (including Global Change and Acid Rain)

The $136.4 million requested for all aspects of air quality R&D would claim over a third of all of the agency's media-specific research funding. Among the driving forces behind the proposed 7.1 percent growth in air research are statutory mandates on air quality (especially the Clean Air Act Amendments of 1990, CAAA), the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) initiative on global change, and policies on acid rain.

Air Quality. Air pollution remains the primary focus of EPA's air-related research, receiving $95.8 million (up 6.5 percent) under the Administration's request for FY 1993. Regulatory mandates dominate the air quality agenda, accounting for most of the proposed growth. For example, $23.5 million would be allocated to R&D on the National Ambient Air Quality Standards (up 26.5 percent). New initiatives include studies on the link between regional haze and aerosols, the effect of sulfur dioxide controls on visibility, and processes that affect acid aerosols. Research would continue on the health effects related to pollutants and the ozone risks to vegetation.

EPA is seeking $22.3 million for research related to hazardous air pollutants (up 29.6 percent). The agency would pursue control technologies for area sources of air toxics, including corona destruction processes and secondary combustion for wood stoves. Scientists would continue to assess cancer and non-cancer effects of high priority air toxics, and refine emissions models and monitoring systems.

Modeling improvements would be the primary focus of the $20.3 million request in support of new source performance standards and state implementation plans (up 23.3 percent). EPA would expand, upgrade, and validate models for ozone, volatile organic compounds (VOC), and for criteria pollutants and their precursors.

Technology R&D would focus on approaches for controlling industrial emissions of SO_x/NO_x and area emissions of VOC.

Funding for research on mobile sources would jump 61.2 percent to $5.7 million. EPA would evaluate the use of remote monitors for emissions, assess the effects of alternative fuels on one regional ecosystem, and compare the effects of conventional and alternative fuels (especially methanol) on human health. The Health Effects Institute would address unregulated hazardous emissions from motor vehicles within a stagnant $3 million budget.

Two areas deemphasized in the Administration's air quality budget are indoor air pollution ($8.0 million, down 1.7 percent) and global change mitigation strategies ($1.7 million, down 50.9 percent). The budget also assumes a 42 percent drop in funding (to $11.4 million) for CAAA-related research not included elsewhere.

Global Change. Recent headlines on ozone depletion caught many by surprise, perhaps even those crafting EPA's budget. While the overall request of $25.7 million for global change represents a 10.4 percent gain over FY 1992, the budget assumes only $4.5 million for R&D on stratospheric ozone depletion, a 19.6 percent reduction from current levels. On the other hand, funding for EPA's contribution to the FCCSET initiative on global change would total $21.3 million (up 19.8 percent).

The budget would support research on the effects of ozone depletion and assessments of regulatory actions needed to protect the ozone layer. Scientists would study the effects of increased ultraviolet-B radiation on terrestrial and aquatic ecosystems, including effects on biogeochemical cycling and the marine food web. The human health component would examine ozone's effects on the immune system, notably heightened susceptibility to infections.

Climate change researchers would identify sources of greenhouse gases and sinks, develop a carbon emissions model, and calculate emissions factors. EPA also wants to quantify carbon fluxes from temperate and high latitude forests and soils, examine how the changing mix of emissions affects their duration and concentration in the troposphere, and study the ground effects resulting from certain chemical transformations. Finally, the agenda includes studies on linkages between climate and ecosystem boundaries and on features that make terrestrial systems vulnerable to climate change.

Acid Deposition. Research needs posed by the National Acid Precipitation Assessment Program and related legislation prompted EPA to request $14.9 million for acid rain research, a 10.5 percent increase from this year. EPA would allocate $4.9 million for technology development (nearly double this year's level), but shift money from the LIMB demonstration (which should be completed in FY 1992) to R&D on low-NO_X technologies. Modelling goals include: establishing baseline trends, measuring area and point emissions, examining transboundary flows, evaluating controls on VOC and oxidants, and testing the impact of strategies authorized by the CAAA (e.g., emissions trading, coal moratoriums). The agency also would maintain the deposition monitoring network, monitor forest and aquatic effects, and analyze factors affecting visibility.

Water Quality R&D

EPA is redirecting much of its water quality R&D, favoring a geographic, ecosystem approach. Concern about the cumulative impact of pollutants on aquatic ecosystems permeates the $32.7 million request for FY 1993, and accounts for most of the 6.7 percent increase in funding.

Researchers would receive $16.3 million (up 10.9 percent) to support the development of permit criteria based on water quality. EPA plans to study the impact of nitrogen compounds from the air, water, and land on estuaries and near coastal areas. The agency also hopes to develop a framework for assessing, managing, and monitoring wetlands and other aquatic and terrestrial habitats. Other tasks include supporting the formulation of National Sediment Quality Criteria for freshwater and marine systems, and improving methods used to monitor discharges, identify pollutant sources, and gauge risks to wildlife and human health.

EPA has asked for $11.5 million (a 5.9 percent increase) to research ecological criteria for regional planning and management of lakes, estuaries, and oceans. The three major stages of this process are to develop measures of ecological integrity, characterize the structure and functions of waterbodies under stress-free conditions, and identify cost-effective strategies to restore ecosystem integrity. Work on this "ecocriteria" initiative would focus initially on the Gulf of Mexico and Great Lakes, extending later to the Chesapeake Bay. Funds also are included to continue research on the special problems of the Great Lakes, notably toxic substances and the zebra mussel.

The budget also calls for new approaches toward wastewater management, shifting away from "classical" treatment technologies toward pollution prevention and risk reduction. Priorities for this $4.8 million program (down 4.0 percent) include managing sediment pollution, curbing discharges from storm water and sewer overflows, and reducing toxic effluents through better plant designs and efficiencies. The budget assumes expanded study of constructed wetlands as an alternative form of wastewater treatment.

Drinking Water R&D

Despite the EPA Science Advisory Board's (SAB's) warning that contaminated drinking water is one of the greatest risks to human health, funding for this component of EPA's research program would fall nearly 1 percent to $21.9 million under the request.

Research on the health effects of drinking water would receive $5.2 million of this total, 5.2 percent less than in FY 1992. These funds would support studies comparing microbial risks with chemical risks, gauging the toxicological risks of complex mixtures, and evaluating the health risks of alternative disinfectants and their byproducts. Support for agency regulatory initiatives would continue.

Funding for technology R&D would remain essentially flat at $9.2 million. Processes for detecting and removing contaminants would undergo testing for their technical and economic merit. The agency also plans to focus on distribution systems, especially ways to eliminate problems resulting from corrosion, unplanned additives, and microbiological contaminants. Efforts to improve methods for sampling and analyzing drinking water would continue.

The $7.5 million proposed for groundwater research (a 1.8 percent gain over FY 1992) would be targeted on interagency R&D on wellhead protection and agrochemicals, and on underground injection control. EPA's participation would focus on detecting contaminant migration (using a watershed approach for agrochemicals), delineating priority wellheads, and calculating risk-management factors. The agency also would test methods for constructing and plugging underground injection wells, and examine the impacts of less-studied sources of contamination.

Pesticides and Toxic Substances R&D

The agency carries out a considerable amount of research concerning the human health and environmental effects of chemical and biological substances in support of the Office of Prevention, Pesticides, and Toxic Substances. While programs for pesticides research and toxic substances research are administered separately, the goals and approaches of individual activities tend to overlap. The request for 8.8 percent growth to $15.8 million in support for pesticides research is lower than those of recent years. Toxic substances research is requested to increase 5.8 percent to $26.8 million.

Test method development programs would see an aggregate increase of 23.6 percent to total funding of $8.8 million. These programs develop and validate exposure and testing protocols to be incorporated into EPA regulations, risk assessment methods, and analytical methods for identifying and quantifying pollutants. Special attention would be paid to three major health areas identified by FCCSET (identification of susceptible populations, neurodegenerative diseases, and *in-vitro* neurotoxicology).

Support for biotechnology programs would increase 2.3 percent to $6.9 million, with particular attention given to research in support of the FCCSET biotechnology initiative. Research is designed to develop a methodology that would allow more rapid application of biotechnology to environmental problems without causing harm to public health. Projects are planned on microbial detection and enumeration technology, transport and dispersal mechanisms, survival and colonization, genetic stability and gene exchange, microbial influence on ecology, and control and mitigation procedures.

Support for the seven programs targeted mainly to human health concerns would increase 5.0 percent to $13.4 million. Among these various activities, research designed to improve exposure monitoring and to perform exposure assessments of pesticides and toxic chemicals would decline 2.0 percent to $3.6 million. New work intended in this area includes the development of immuno-based personal exposure monitoring devices using antibodies as receptors and immuno-based techniques to analyze pesticide residues, and studies concerning multiple pathways to exposure. Researchers would work on indicators of biological dose and resulting effects for application to studies of human populations and markers to identify episodes of exposure to pollutants. A prototype system to predict structure-activity relationships is requested to increase 13.3 percent to $1.9 million, and studies concerning asbestos would continue to be funded at a level of $1.1 million.

A 4.6 percent increase to $9.8 million would be devoted to ecological studies concerning transport, fate, field validation, ecotoxicity, and risk assessment of pesticides and other toxics. The pesticide ecological transport/fate field validation program would grow 8.9 percent to $3.9 million. By comparison, the similar program for toxic substances and ecotoxicity and risk assessment programs in both media would grow by less than inflation. Intended outcomes of planned projects include the refinement of predictive models and techniques addressing transport, degradation, fate, and residual problems of toxic substances, and the determination of factors that impair important environmental processes. Studies would focus on using bioindicators to assess the condition of habitats and on the impact of pollutants on long-term survival of wildlife.

Radiation R&D

EPA is seeking a 16.5 percent increase that would bring support of radiation research to $4.1 million. The programs would continue to provide scientific data on exposure and risk from radioactive materials to EPA's Office of Radiation Programs, as well as to various other federal, state, and local agencies.

The radon program is slated to increase 29.4 percent to $1.9 million. Scientists plan to perform the first full-scale simulation of physical parameters affecting radon entry into research homes. Determination of radon entry processes and development of innovative technology to mitigate indoor air concerns would continue to be priorities in the radon research program. Specific designs for radon-resistant large buildings, particularly schools, are also planned.

Support for research into specific mechanisms of action and exposure conditions for electric and magnetic field radiation would continue to be funded at $1.9 million. Exposure assessments and dose-responses relationships would be determined in order to predict cancer risks. Projects to determine reproductive, developmental, and neurological effects are being considered by EPA's SAB.

Hazardous Waste R&D

Judging from the $39.8 million bottom line, hazardous waste has moved down the list of research priorities. After adjusting for the transfer of oil spill R&D to a separate Oil Spill Response account, the budget is headed down 12.0 percent. At issue are congressional earmarks: EPA's decision to discontinue them explains almost all of the reduction in this area. Dropping earmarked projects would plunge funding for "special research centers" from $3.7 million to $0.4 million (down 89.6 percent). The budget for R&D on alternative technologies would fall 44.7 percent (to $6.3 million), partly because of the elimination of $2.9 million for FY 1992 earmarks.

Not all projects would fare poorly. Municipal solid waste research would gain nearly 30 percent, rising to $7.5 million as EPA expands research on waste reuse/recycling, source reduction, and the health effects of combustor emissions and leachate from municipal landfills. (No other funds are requested for research on land disposal.) EPA would devote $3.5 million (up 11.5 percent) to research on pollution prevention, focusing on products and production technologies that minimize waste. The increase is attributed to EPA's role in the FCCSET initiative on Advanced Materials and Processing. Technology transfer would receive $2.3 million (up 37 percent).

On the down side, EPA shaved 7.3 percent from the budget for R&D on techniques for identifying and characterizing hazardous wastes. The remaining $13.6 million would be used develop analytical tools for detecting, evaluating, and predicting toxic and hazardous constituents in the air, soil, and groundwater, with an emphasis on subsurface monitoring techniques (e.g., borehole geophysics and fiber optic sensors). A pared-back, $2.2 million budget for incineration R&D (down 24.9 percent) would support tests of thermal treatment devices, studies of toxic and hazardous emissions from industrial plants and incinerators, and related health effects.

Funding for other aspects of the hazardous waste research agenda would remain essentially flat. The $2.6 million allocated for R&D on preventing, detecting, and correcting releases from underground storage tanks would focus on active leaks, passive bioremediation, and non-gasoline hydrocarbons. Few changes are planned for the $1.4 million quality assurance program.

Superfund R&D

EPA has proposed $68.9 million for Superfund R&D (up 3.2 percent). The added money would be spread unevenly, with cleanup, risk assessments, and technical support posting big gains, while earmarked projects get the axe.

R&D on cleanup technologies would receive $12.2 million next year (up 53.2 percent), primarily to bolster EPA's "Technology Innovation" initiative. EPA hopes that bioconversion processes and other biotechnology innovations could yield usable industrial products (e.g., feedstocks). R&D on *in-situ* bioremediation would continue, but with more emphasis on understanding the site variables that affect treatment options. Attention would shift from more established technologies to lab studies of emerging techniques, and from site assessment methods (which would be cut 20.2 percent to $2.3 million) to engineering decision aids.

Funding for research on health and ecological risk would rise 37.1 percent to $11.4 million, partly to expand research on ecological processes affecting *in-situ* remediation and subsurface transport and fate. Citing the urgent need for technical support for the agency's cost-recovery and remedial planning efforts, EPA has requested $11.0 million for program assistance (up 21.5 percent). The budget also proposes $3.2 million for quality assurance to support the Contract Laboratory Program (up 4.0 percent). However, EPA would curtail scientific assistance in evaluating "reportable quantities" of listed chemicals ($0.5 million, down 15.9 percent).

EPA would change the focus but not the funding for the Superfund Innovative Technology Evaluation program on advanced treatment and monitoring systems. The $18.3 million for FY 1993 would be redirected to integrated, multi-process systems, and new technologies for chemical detection, such as fiber optics and electrochemical sensors. The $1.3 million proposed for other technology transfer programs is identical to this year's budget.

Finally, funding for University Research Centers would register a modest 2.0 percent gain (to $5.1 million). Separately, EPA would delete $7.5 million earmarked in FY 1992 for three "special research activities" leaving $1.0 million for Hispanic and Native American researchers at the University of Texas, El Paso.

Other Trust Fund R&D

Funding for engineering studies related to **Leaking Underground Storage Tanks** sites would remain unchanged at $0.8 million in FY 1993. Researchers would evaluate above-ground and subsurface treatment technologies, document case studies, monitor releases and cleanups, and assist in site plans and assessments. Beginning in FY 1993, R&D on oil spills will be funded under a separate appropriation from the "**Oil Spill Response Trust Fund**." This research program (which was housed under water quality in FY 1991 and hazardous waste in FY 1992) would spend $2.6 million next year on cleanup technologies for specific types of spills.

Agency Tables

Table II-1. R&D in the FY 1993 Budget by Agency in Current Dollars (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change, FY 1992-93 Current $	Percent Change, FY 1992-93 Constant $
Total R&D (Conduct and Facilities):					
Defense (military)	$37,208.5	$39,159.2	$40,083.8	2.4%	-0.9%
National Aeronautics and Space Administration	8,123.9	8,561.6	9,308.4	8.7%	5.2%
Energy	7,338.7	8,251.3	8,092.2	-1.9%	-5.1%
Health and Human Services	9,566.3	10,338.5	10,740.2	3.9%	0.5%
National Institutes of Health	(7,890.4)	(8,538.9)	(8,972.6)	5.1%	1.7%
National Science Foundation	1,893.4	2,065.0	2,508.0	21.5%	17.5%
Agriculture	1,391.1	1,497.7	1,403.2	-6.3%	-9.3%
Interior	620.0	595.1	550.5	-7.5%	-10.5%
Transportation	411.1	474.9	518.4	9.2%	5.6%
Environmental Protection Agency	458.9	502.0	528.4	5.3%	1.9%
Commerce	536.8	612.8	654.7	6.8%	3.4%
Education	162.8	172.2	217.4	26.2%	22.2%
Agency for International Development	347.9	335.3	339.2	1.2%	-2.1%
Veterans Administration	224.2	234.2	247.7	5.8%	2.4%
Nuclear Regulatory Commission	108.5	120.0	127.7	6.4%	3.0%
Smithsonian	104.0	107.0	125.0	16.8%	13.1%
Tennessee Valley Authority	73.7	92.7	55.0	-40.7%	-42.6%
Corps of Engineers	42.5	54.4	72.4	33.1%	28.8%
Labor	44.9	37.2	51.2	37.6%	33.2%
Housing and Urban Development	27.7	24.2	34.2	41.3%	36.8%
Justice	43.7	43.7	51.3	17.4%	13.6%
Treasury	17.9	17.9	17.9	0.0%	-3.2%
TOTAL R&D	$68,746.5	$73,296.9	$75,726.8	3.3%	0.0%

Table II-1. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change, FY 1992-93 Current $	Percent Change, FY 1992-93 Constant $
Conduct of R&D:					
Defense (military)	$36,764.8	$38,702.0	$39,686.0	2.5%	-0.8%
National Aeronautics and Space Administration	7,348.5	7,706.4	8,672.6	12.5%	8.9%
Energy	6,129.2	6,550.0	6,564.0	0.2%	-3.0%
Health and Human Services	9,381.4	10,215.6	10,648.7	4.2%	0.9%
National Institutes of Health	(7,714.0)	(8,422.7)	(8,888.1)	5.5%	2.1%
National Science Foundation	1,859.0	1,967.0	2,375.0	20.7%	16.9%
Agriculture	1,226.4	1,328.2	1,332.3	0.3%	-2.9%
Interior	591.7	582.8	539.8	-7.4%	-10.4%
Transportation	392.9	446.1	497.5	11.5%	7.9%
Environmental Protection Agency	439.7	497.0	525.9	5.8%	2.4%
Commerce	520.9	589.6	622.7	5.6%	2.2%
Education	158.6	170.1	215.3	26.6%	22.5%
Agency for International Development	334.5	322.4	325.0	0.8%	-2.4%
Veterans Administration	219.4	229.7	245.2	6.7%	3.3%
Nuclear Regulatory Commission	108.5	120.0	127.7	6.4%	3.0%
Smithsonian	104.0	107.0	125.0	16.8%	13.1%
Tennessee Valley Authority	69.0	87.7	55.0	-37.3%	-39.3%
Corps of Engineers	42.5	54.4	72.4	33.1%	28.8%
Labor	44.9	37.2	51.2	37.6%	33.2%
Housing and Urban Development	27.7	24.2	34.2	41.3%	36.8%
Justice	43.7	43.7	51.3	17.4%	13.6%
Treasury	17.9	17.9	17.9	0.0%	-3.2%
Total Conduct of R&D	$65,825.1	$69,799.0	$72,784.7	4.3%	0.9%

Table II-1. R&D in the FY 1993 Budget by Agency in Current Dollars (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change, FY 1992-93 Current $	Percent Change, FY 1992-93 Constant $
Total R&D (Conduct and Facilities):					
Defense (military)	$37,208.5	$39,159.2	$40,083.8	2.4%	-0.9%
National Aeronautics and Space Administration	8,123.9	8,561.6	9,308.4	8.7%	5.2%
Energy	7,338.7	8,251.3	8,092.2	-1.9%	-5.1%
Health and Human Services	9,566.3	10,338.5	10,740.2	3.9%	0.5%
National Institutes of Health	(7,890.4)	(8,538.9)	(8,972.6)	5.1%	1.7%
National Science Foundation	1,893.4	2,065.0	2,508.0	21.5%	17.5%
Agriculture	1,391.1	1,497.7	1,403.2	-6.3%	-9.3%
Interior	620.0	595.1	550.5	-7.5%	-10.5%
Transportation	411.1	474.9	518.4	9.2%	5.6%
Environmental Protection Agency	458.9	502.0	528.4	5.3%	1.9%
Commerce	536.8	612.8	654.7	6.8%	3.4%
Education	162.8	172.2	217.4	26.2%	22.2%
Agency for International Development	347.9	335.3	339.2	1.2%	-2.1%
Veterans Administration	224.2	234.2	247.7	5.8%	2.4%
Nuclear Regulatory Commission	108.5	120.0	127.7	6.4%	3.0%
Smithsonian	104.0	107.0	125.0	16.8%	13.1%
Tennessee Valley Authority	73.7	92.7	55.0	-40.7%	-42.6%
Corps of Engineers	42.5	54.4	72.4	33.1%	28.8%
Labor	44.9	37.2	51.2	37.6%	33.2%
Housing and Urban Development	27.7	24.2	34.2	41.3%	36.8%
Justice	43.7	43.7	51.3	17.4%	13.6%
Treasury	17.9	17.9	17.9	0.0%	-3.2%
TOTAL R&D	$68,746.5	$73,296.9	$75,726.8	3.3%	0.0%

Table II-2. R&D in the Department of Defense - FY 1993 Budget (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.[1]	FY 1993 Budget	Percent Change FY 1992-93
Research, Development, Test, and Evaluation:				
Research	$1,156.9	$1,180.6	$1,124.0	-4.8%
Exploratory Development	2,729.6	2,983.9	2,960.0	-0.8%
Technology Base	$3,886.4	$4,164.6	$4,084.0	-1.9%
Advanced Technology Development	$5,298.2	$6,489.5	$7,682.3	18.4%
Strategic Programs	4,374.6	4,635.4	4,647.2	0.3%
Tactical Programs	12,610.7	14,811.7	13,241.0	-10.6%
Intelligence and Communications Programs	4,470.6	5,201.5	5,011.2	-3.7%
Defense-wide Mission Support	4,229.7	4,141.8	4,147.0	0.1%
BA Adjustment	1,322.9	-1,340.2	--	--
TOTAL, RDT&E	$36,193.1	$38,104.4	$38,812.7	1.9%
Defense Health Program[2]	--	--	305.9	--
Other Appropriations[3]	1,015.4	1,054.8	965.2	-8.5%
TOTAL, DOD R&D	$37,208.5	$39,159.2	$40,083.8	2.4%
TOTAL Conduct of R&D	$36,764.8	$38,702.0	39,686.0	2.5%
TOTAL R&D Facilities	$443.7	$457.2	$397.8	-13.0%

Sources: Department of Defense "RDT&E Programs (R-1)," OMB data for R&D, and *Budget of the United States Government, Supplement* (February 1992).

[1] FY 1992 estimates do not assume enactment of proposed rescissions.

[2] These activities, currently with RDT&E, would be funded under a new account beginning in FY 1993.

[3] R&D support in military personnel, military construction, and other DOD appropriations.

Table II-3. DOD R&D by Military Departments and Agencies (budget authority in millions)[1]

	FY 1991 Actual	FY 1992 Est.[2]	FY 1993 Budget	Percent Change FY 1992-93
Research, Development, Test, and Evaluation:				
Army	$5,654.3	$6,519.8	$5,414.5	-17.0%
Navy	9,014.4	7,674.5	8,517.8	11.0%
Air Force	12,207.5	13,737.5	14,532.4	5.8%
Defense Agencies	9,066.1	9,949.5	10,053.4	1.0%
Defense Mapping Agency	231.1	233.3	62.1	-73.4%
Strategic Defense Initiative Organization	2,868.8	4,115.5	5,312.4	29.1%
Office, Secretary of Defense	2,374.1	1,512.9	1,076.6	-28.8%
Defense Advanced Research Projects Agency	1,455.5	1,562.6	1,293.6	-17.2%
Defense Nuclear Agency	446.5	488.4	477.0	-2.3%
Defense Support Project Office	57.3	230.4	259.1	12.5%
Joint Chiefs of Staff	79.6	59.8	32.8	-45.1%
Defense Communications Agency	165.8	132.8	101.1	-23.9%
Defense Logistics Agency	38.2	37.1	19.5	-47.5%
Uniformed Services University of the Health Sciences	2.5	3.2	--	-100.0%
Special Operations Command	190.6	300.5	262.9	-12.5%
Other[3]	1,156.1	1,273.1	1,156.3	-9.2%
Director of Test and Evaluation, Defense	237.3	210.2	281.7	34.0%
Director of Operational Test and Evaluation	13.6	12.8	13.0	1.1%
TOTAL RDT&E	$36,193.1	$38,104.4	$38,812.7	1.9%

Table II-3. (continued)

	FY 1991 Actual	FY 1992 Est.[2]	FY 1993 Budget	Percent Change FY 1992-93
Defense Health Program[4]	--	--	305.9	--
Other appropriations[5]	1,015.4	1,054.8	965.2	-8.5%
TOTAL DOD R&D	$37,208.5	$39,159.2	$40,083.8	2.4%

Source: Department of Defense "RDT&E Programs (R-1)," and OMB data for R&D for FY 1993, and *Budget of the United States Government, Supplement* (February 1992).

[1] Includes conduct of R&D and R&D facilities.
[2] FY 1992 estimates do not assume enactment of proposed rescissions.
[3] Other includes National Security Agency and Defense Intelligence Agency.
[4] In FY 1991 and 1992, funds for this R&D were appropriated within the RDT&E accounts.
[5] R&D support in military personnel, military construction, and other DOD appropriations.

Table II-4. Department of Defense R&D by Character of Work FY 1993 Budget (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.[1]	FY 1993 Budget	Percent Change FY 1992-93
CURRENT DOLLARS				
Basic Research	$1,156.9	$1,180.6	$1,204.0	2.0%
Applied Research	2,729.6	2,983.9	3,055.0	2.4%
Total Research	$3,886.5	$4,164.6	$4,259.0	2.3%
Development[2]	32,878.3	34,537.4	35,427.0	2.6%
Total Conduct of R&D	$36,764.8	$38,702.0	$39,686.0	2.5%
R&D Facilities	443.7	457.2	397.8	-13.0%
TOTAL R&D	$37,208.5	$39,159.2	$40,083.8	2.4%

Table II-4. (continued)

	FY 1991 Actual	FY 1992 Est.[1]	FY 1993 Budget	Percent Change FY 1992-93
CONSTANT FY 1987 DOLLARS				
Basic Research	$988.0	$978.0	$965.2	-1.3%
Applied Research	2,331.2	2,471.8	2,449.1	-0.9%
TOTAL Research	$3,319.2	$3,449.8	$3,414.3	-1.0%
Development[2]	28,079.5	28,609.5	28,400.7	-0.7%
Total Conduct of R&D	$31,398.8	$32,059.3	$31,815.0	-0.8%
R&D Facilities	378.9	378.7	318.9	-15.8%
TOTAL R&D	$31,777.7	$32,438.0	$32,133.9	-0.9%

Source: OMB data for R&D for FY 1993. Constant dollar conversions based on OMB's GDP deflators.

[1] FY 1992 estimates do not assume enactment of proposed rescissions.

[2] Includes expenses of test and evaluation.

Table II-5. Department of Defense Funding for Basic Research - FY 1993 (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.[1]	FY 1993 Budget	Percent Change FY 1992-93
Army				
Defense Research Sciences	$171.8	$190.9	$166.6	-12.7%
In-House Independent Research	8.8	8.9	6.7	-25.1%
Electromechanics and Hypervelocity Physics	0.0	3.0	3.9	31.4%
TOTAL Army	$180.6	$202.8	$177.2	-12.6%
Navy				
Defense Research Sciences	$366.1	$381.2	$457.4	20.0%
In-House Independent Research	24.1	14.0	16.2	15.6%
TOTAL, Navy	$390.2	$395.2	$473.6	19.8%
Air Force				
Defense Research Sciences	$197.4	$209.2	$237.4	13.5%
In-House Independent Research	7.2	7.9	9.8	23.4%
TOTAL, Air Force	$204.6	$217.2	$247.2	13.8%
Defense Agencies				
Defense Research Sciences	$82.2	$112.4	$126.1	12.2%
In-House Independent Research	2.5	3.2	--	--
University Research Initiative	242.2	226.0	99.9	-55.8%
Research Projects	39.6	--	--	--
US-Japan Management Training	10.0	9.8	--	--
Critical Technology Center	4.9	--	--	--
Unspecified[1]	--	15.0	--	-100.0%
TOTAL, Defense Agencies	$381.4	$366.3	$226.0	-38.3%

Table II-5. (continued)

	FY 1991 Actual	FY 1992 Est.[1]	FY 1993 Budget	Percent Change FY 1992-93
Defense Health Program	--	--	$80.0	--
Total DOD				
Defense Research Sciences	$817.5	$893.7	$987.5	10.5%
In-House Independent Research	42.6	34.1	32.7	-4.1%
University Research Initiative	242.2	226.0	99.9	-55.8%
Research Projects	39.6	--	--	--
Electromechanics and Hypervelocity Physics	0.0	3.0	3.9	31.4%
US-Japan Management Training	10.0	9.8	--	-100.0%
Critical Technology Center	4.9	--	--	--
Unspecified[1]	--	15.0	--	-100.0%
Defense Health Program	--	--	80.0	--
TOTAL, DOD Basic Research	$1,156.9	$1,180.6	$1,204.0	2.0%

Source: Department of Defense "RDT&E Programs (R-1)," OMB data for R&D for FY 1993, and ***Budget of the United States Government, Supplement*** (February 1992), and House Report 101-328.

[1] FY 1992 estimates do not assume enactment of proposed recissions. The figures in the R-1 assume a rescission of an estimated $156.4 million from basic research in FY 1992. In the absense of details from OMB, the authors restored these amounts by service and line item by assuming the FY 1992 appropriated level for the affected activities.

Table II-6. Trends in Department of Defense R&D, FY 1965 - FY 1993 (budget authority in millions)

	Basic Research[1]		Total DOD R&D	
FISCAL YEAR	Current Dollars	Constant FY 1987 $	Current Dollars	Constant FY 1987 $
1965	$347	$1,227	$6,865	$24,284
1970	323	934	7,491	21,669
1975	305	641	9,167	19,266
1980	552	782	14,150	20,048
1981	615	791	16,772	21,569
1982	697	834	20,866	24,974
1983	787	904	23,233	26,698
1984	843	928	26,940	29,653
1985	851	902	31,632	33,537
1986	954	982	35,000	36,038
1987	894	894	37,136	37,136
1988	897	866	38,126	36,791
1989	951	879	38,578	35,644
1990	936	831	37,869	33,611
1991	1,157	988	37,209	31,778
1992 (Estimate)[2]	1,181	978	39,159	32,438
1993 (Budget)	1,204	965	40,084	32,134

Source: National Science Foundation historical reports, OMB data on R&D for FY 1993, and *Budget of the United States Government, Supplement* (February 1992). Constant dollar conversions based on OMB's GDP deflators.

[1] Budget authority for DOD "6.1" category.

[2] FY 1992 estimates do not assume enactment of proposed rescissions.

Table II-7. R&D in the National Science Foundation (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Mathmatical and Physical Sciences (MPS)				
Mathematical Sciences	$73.2	$78.6	$85.0	8.1%
Astronomical Sciences	95.6	112.3	120.0	6.9%
Physics	130.1	138.4	148.6	7.4%
Chemistry	104.7	112.3	126.0	12.1%
Materials Research	134.1	143.6	167.5	16.6%
Major Research Equipment	22.5	37.9	79.0	108.4%
TOTAL, MPS	$564.1	$623.1	$726.0	16.5%
Engineering (ENG)				
Biological and Critical Systems	$36.0	$39.4	$46.0	16.7%
Chemical and Thermal Systems	33.0	36.4	43.6	19.8%
Design and Manufacturing Systems	20.5	22.6	31.1	37.7%
Electrical and Communication Systems	31.9	35.2	44.0	25.0%
Engineering Education Centers	70.1	75.5	88.6	17.3%
Industrial Innovation Interface	22.8	24.2	30.0	24.0%
Mechanical and Structural Systems	23.4	25.3	29.4	16.2%
TOTAL, ENG	$237.66	$258.46	$312.52	20.9%

Table II-7. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Biological Sciences (BIO)				
Molecular and Cellular Biosciences	$76.7	$82.9	$95.5	15.2%
Integrative Biology and Neuroscience	72.4	77.1	88.5	14.7%
Environmental Biology	68.3	72.7	86.5	19.0%
Biological Instrumentation and Resources	37.7	41.6	50.2	20.5%
TOTAL, BIO	$255.1	$274.3	$320.6	16.9%
Geosciences (GEO)				
Atmospheric Sciences	$116.6	$127.2	$151.9	19.5%
Earth Sciences	70.8	76.2	88.1	15.6%
Ocean Sciences	164.6	178.8	206.4	15.4%
Arctic Research Program	14.9	21.3	26.0	21.9%
Science and Technology Centers	0.8	0.9	0.0	-100.0%
TOTAL, GEO	$367.7	$404.4	$472.4	16.8%
Computer Information Science and Engineering (CISE)				
Computer and Computation Research	$31.3	$34.8	$43.0	23.5%
Information, Robotics and Intelligent Systems	23.6	27.0	36.8	36.5%
Microelectronic Information Processing Systems	18.5	21.5	30.4	41.5%
Advanced Scientific Computing	66.5	69.6	86.7	24.6%
Networking and Communications Research & Infrastructure	29.8	35.5	48.1	35.5%
Cross-Disciplinary Activities	19.8	22.5	27.1	20.4%
TOTAL, CISE	$189.5	$210.9	$272.2	29.1%

Table II-7. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Social, Behavioral and Economic Sciences (SBE)				
Social and Economic Science	$35.9	$40.5	$49.1	21.4%
Behavioral and Cognitive Sciences	20.7	22.2	24.9	11.9%
International Cooperative Scientific Activities	12.8	12.6	14.9	18.3%
Science Resources Studies	9.9	10.6	18.9	78.7%
TOTAL, SBE	$79.2	$85.9	$107.8	25.5%
Experimental Program to Stimulate Competitive Research[1]	10.0	18.0	0.0	-100.0%
Program Development and Management	0.3	--	--	--
Adjustments	-9.4	-1.0	--	--
TOTAL, Research and Related Activities	$1,694.2	$1,874.0	$2,211.5	18.0%
Education and Human Resources (EHR)				
Systematic Reform[1]	$16.4	$44.5	$76.0	70.8%
Elementary and Secondary Education	149.0	192.4	186.4	-3.1%
Undergraduate Education	52.4	61.0	63.0	3.3%
Graduate Education and Research Development	44.0	78.4	57.9	-26.1%
Human Resource Development	34.6	46.6	50.1	7.5%
Research, Evaluation, and Dissemination	25.6	42.2	46.2	9.5%
Adjustments	0.4	--	--	--
TOTAL, EHR	$322.3	$465.0	$479.5	3.1%

Table II-7. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Academic Research Facilities and Instrumentation	$20.5	$33.0	$33.0	0.0%
Critical Technologies Institute[2]	--	--	1.0	--
U.S. Antarctica Program, Total Federal Funds[3]	175.0	193.0	177.0	-8.3%
Salaries and Expenses	101.0	109.0	135.0	23.9%
Inspector General	3.0	3.5	4.0	14.3%
Deduct Antarctica funds from other appropriations[3]	--	-105.0	-14.0	-86.7%
TOTAL, NSF Budget Authority	$2,316.0	$2,572.5	$3,027.0	17.7%
Deduct Science Education other than R&D and other non-R&D	-422.6	-507.5	-519.0	2.3%
TOTAL, NSF R&D	$1,893.4	$2,065.0	$2,508.0	21.5%
TOTAL, Conduct of R&D	$1,859.0	$1,967.0	$2,375.0	20.7%
TOTAL, R&D Facilities	$34.4	$98.0	$133.0	35.7%

Source: Agency budget justification and OMB data for R&D for FY 1993.

[1] FY 1993 funding for EPSCOR is included under EHR's "Systematic Reform."

[2] Management responsibility for this Institute was transferred to NSF in FY 1992, funded by reimbursements from the Department of Defense ($5.0 million) and the Office of Science and Technology Policy ($1.6 million).

[3] FY 1992 figures include $30 million derived from the Department of Defense, $70 million from a rescission from HUD, and $5 million from a rescission from NSF's R&RA appropriation. FY 1993 includes $14 million from DOD.

Table II-8. R&D in the Department of Health and Human Services (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Health				
National Institutes of Health	$7,890.4	$8,538.9	$8,972.6	5.1%
Alcohol, Drug Abuse and Mental Health Administration	1,087.0	1,148.3	1,203.7	4.8%
Centers for Disease Control	113.2	117.2	118.1	0.8%
Food and Drug Administration	125.0	139.4	146.3	4.9%
Assistant Secretary for Health	10.5	8.9	4.4	-50.6%
Health Care Financing Administration	69.0	78.4	36.0	-54.1%
Health Resources and Services Administration	10.7	11.7	11.7	0.0%
Indian Health Services	0.7	0.7	0.8	14.3%
Health Care Policy and Research	101.1	106.6	73.9	-30.7%
Total, Health	$9,407.6	$10,150.1	$10,567.5	4.1%

Table II-8. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Human Services				
Administration for Children & Families	$129.0	$155.3	$142.2	-8.4%
Social Security Administration	20.8	28.1	25.3	-10.0%
Office of the Secretary	8.9	5.0	5.2	4.0%
Total, Human Services	$158.7	$188.4	$172.7	-8.3%
TOTAL, HHS R&D	$9,566.3	$10,338.5	$10,740.2	3.9%
Total Conduct of R&D	$9,381.4	$10,215.6	$10,648.7	4.2%
Total R&D Facilities	$184.9	$122.9	$91.5	-25.5%

Source: OMB data for R&D for FY 1993 and agency budget justifications.

Table II-9. National Institutes of Health R&D, by Institute (budget authority in millions)

INSTITUTES	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Cancer	$1,674.4	$1,914.3	$1,973.2	3.1%
Heart, Lung and Blood	1,080.2	1,144.8	1,198.7	4.7%
Dental Research	142.7	153.2	160.7	4.9%
Diabetes, Digestive and Kidney Diseases	591.6	637.3	674.4	5.8%
Neurological Disorders and Stroke	529.0	568.5	601.8	5.9%
Allergy and Infectious Diseases	886.9	940.7	990.7	5.3%
General Medical Sciences	665.8	723.1	770.0	6.5%
Child Health & Human Development	462.6	502.8	528.3	5.1%
Eye	246.2	263.0	277.8	5.6%
Environmental Health Sciences	229.7	241.1	250.6	3.9%
Aging	312.9	372.7	396.4	6.4%
Arthritis & Musculoskeletal & Skin Diseases	187.1	197.1	208.1	5.6%
Deafness and Communications Disorders	131.7	145.1	153.3	5.6%
Research Resources	333.1	311.9	327.6	5.0%
Nursing Research	35.6	40.6	44.2	8.9%
Human Genome	83.7	100.8	106.3	5.5%
Fogarty International Center	17.5	19.6	20.7	5.7%
National Library of Medicine	94.8	103.3	108.7	5.2%
Office of Director	97.7	142.1	203.4	43.1%
Buildings and Facilities	168.7	103.8	72.5	-30.2%
Adjustments	-81.2	-86.8	-94.7	9.1%
TOTAL R&D, NIH	$7,890.4	$8,538.9	$8,972.6	5.1%
Conduct of R&D	$7,714.0	$8,422.7	$8,888.1	5.5%
R&D Facilities	$176.4	$116.2	$84.5	-27.3%

Source: Agency budget justification.

[1] Excludes training. Please note: In contrast to AAAS reports from prior years, these figures include buildings and facilities.

Table II-10. R&D in the National Institutes of Health by Funding Mechanism (budget authority in millions)[1]

FUNDING MECHANISMS	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Research Grants:				
Research projects	$4,520.3	$4,927.4	$5,276.6	7.1%
Noncompeting	(3,275.3)	(3,555.9)	(3,932.2)	10.6%
Administrative Supplementals	(52.1)	(23.0)	(23.8)	3.5%
Competing	(1,193.0)	(1,348.5)	(1,320.6)	-2.1%
Research Centers	699.3	786.9	787.7	0.1%
Other Research Grants	414.6	398.2	395.9	-0.6%
R&D Contracts	594.3	644.4	644.4	0.0%
Intramural Research	923.4	992.0	1,042.4	5.1%
Research Management and Support	365.8	411.4	431.6	4.9%
Cancer Control	85.4	106.2	91.1	-14.2%
Other	110.9	156.3	218.4	39.7%
TOTAL, Conduct of R&D	$7,714.0	$8,422.7	$8,888.1	5.5%

Source: Agency budget justification.

[1] Excludes training and buildings and facilities.

Table II-11. Research in the Alcohol, Drug Abuse, and Mental Health Administration (budget authority in millions)[1]

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
General Mental Health	$494.7	$544.7	$580.2	6.5%
Drug Abuse	290.4	303.9	321.4	5.8%
Alcoholism	151.2	164.8	173.5	5.3%
Treatment Outcome Research	$8.0	$8.6	$8.9	3.4%
Undistributed R&D	142.7	126.3	119.7	-5.2%
TOTAL R&D	$1,087.0	$1,148.3	$1,203.7	4.8%
Conduct of R&D	$1,078.5	$1,143.3	$1,199.7	4.9%
R&D Facilities	$8.5	$5.0	$4.0	-20.0%

Source: Agency budget justification.

[1] Excludes training and community programs.

Table II-12. R&D in the Department of Energy (budget authority in millions)[1]

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
DOE Appropriations Containing R&D:				
Energy Supply R&D	$1,929.8	$2,053.1	$2,109.2	2.7%
Fossil Energy R&D	385.6	361.4	241.2	-33.3%
Energy Conservation	196.7	236.5	297.4	25.8%
General Science and Research	1,127.9	1,455.1	1,632.5	12.2%
Atomic Energy Defense Activities	2,997.7	3,348.0	2,968.8	-11.3%
Uranium Enrichment	152.7	163.6	100.0	-38.9%
Clean Coal Technology	361.4	390.0	500.0	28.2%
Bonneville Power Administration	18.1	19.8	20.0	1.0%
Environmental Restoration	168.8	223.9	223.2	-0.3%
TOTAL, DOE R&D	$7,338.7	$8,251.3	$8,092.2	-1.9%
Energy Supply R&D				
Solar and Renewable Energy				
Solar Building Energy Systems	$2.0	$2.0	$2.0	0.0%
Photovoltaic Energy Systems	46.1	60.4	63.5	5.1%
Solar Thermal Energy Systems	19.1	29.1	27.0	-7.2%
Biofuels Energy Systems	32.9	39.3	48.4	23.0%
Wind Energy Systems	11.0	21.4	22.0	2.8%
Ocean Energy Systems	2.6	2.0	0.0	-100.0%
International Solar Energy Program	1.5	2.0	2.0	0.0%
Solar Technology Transfer	2.2	1.0	2.0	100.0%
National Renewable Energy Laboratory[2]	5.1	11.5	6.6	-43.1%
Program Support and Resource Assessment	1.9	2.1	2.1	0.6%
TOTAL, Solar and Renewable Energy	$124.3	$170.8	$175.5	2.8%

Table II-12. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Geothermal	$26.2	$26.2	$23.5	-10.3%
Hydropower	$0.9	$1.0	$1.0	0.3%
Nuclear Energy				
Light Water Reactors	$44.3	$62.5	$58.7	-6.1%
Advanced Reactor R&D	61.3	59.5	50.0	-16.0%
Advanced Radio Isotope Power Systems	86.9	51.0	51.8	1.6%
Space/Reactor Power Systems	33.3	40.0	30.0	-25.0%
Space Exploration Initiative	0.0	5.0	10.0	100.0%
Facilities	91.1	97.8	95.1	-2.8%
Use of Prior Balances	-8.0	0.0	-34.0	--
TOTAL, Nuclear Energy	$308.9	$315.9	$261.6	-17.2%
Electric Energy and Storage Systems	$39.5	$36.9	$38.9	5.4%
Biological and Environmental Research	$359.9	$347.2	$378.1	8.9%
Environment Safety & Health^3	--	--	--	--
Magnetic Fusion	$281.0	$329.5	$350.2	6.3%
Basic Energy Sciences				
Materials Sciences	$272.0	$257.1	$290.2	12.9%
Chemical Sciences	155.6	158.3	175.4	10.8%
Applied Mathematical Sciences	52.1	81.5	91.0	11.7%
Engineering and Geosciences	33.9	35.8	39.5	10.4%
Advanced Energy Projects	24.7	54.8	11.9	-78.3%
Energy Biosciences	21.8	24.7	27.6	11.7%
Capital Equipment and Construction	139.2	145.0	169.8	17.1%
TOTAL, Basic Energy Sciences	$699.4	$757.2	$805.5	6.4%

Table II-12. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Energy Supply (continued)				
Energy Research Analyses	$3.6	$4.0	$4.0	0.0%
University and Science Education	$44.9	$54.5	$55.7	2.2%
Technology Transfer	$2.5	$9.9	$15.1	52.5%
Small Business Innovation Res.	$38.8	$0.0	$0.0	--
TOTAL, Energy Supply R&D	$1,929.8	$2,053.1	$2,109.2	2.7%
Fossil Energy R&D				
Coal	$289.4	$279.3	$153.3	-45.1%
Petroleum	59.2	57.3	57.0	-0.4%
Gas	15.9	12.6	40.0	218.2%
Cooperative R&D	11.9	10.9	5.0	-54.0%
Facilities	15.8	10.4	2.9	-72.5%
Adjustments	-6.5	-9.0	-17.0	88.9%
TOTAL, Fossil Energy R&D	$385.6	$361.4	$241.2	-33.3%
Energy Conservation R&D				
Building Technologies	$33.4	$36.3	$38.8	7.0%
Industrial Technologies	73.5	85.3	93.0	9.0%
Transportation Technologies	76.0	100.6	151.0	50.0%
Utility Technologies	4.2	4.7	6.0	26.6%
Technical and Financial Assistance	9.6	9.5	8.7	-9.1%
TOTAL, Energy Conservation R&D	$196.7	$236.5	$297.4	25.8%

Table II-12. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
General Science and Research				
High Energy Physics	$582.8	$628.0	$630.9	0.5%
Nuclear Physics	310.7	354.4	363.5	2.6%
Superconducting Super Collider[4]	234.4	472.7	638.1	35.0%
TOTAL, General Science and Research	$1,127.9	$1,455.1	$1,632.5	12.2%
Atomic Energy Defense Activities				
Naval Reactors Development	$638.0	$679.2	$712.9	5.0%
Weapons R&D and Testing	1,741.7	1,944.1	1,862.2	-4.2%
Verification and Control Technology	66.6	71.4	76.8	7.6%
Nuclear Safeguards and Security	39.4	34.7	35.6	2.6%
Materials Production	156.1	160.0	166.9	4.3%
New Production Reactor	350.1	447.0	108.9	-75.6%
Office of Intelligence	5.8	5.5	5.5	0.0%
University and Science Education	0.0	6.1	0.0	-100.0%
TOTAL, Atomic Energy Defense Activities	$2,997.7	$3,348.0	$2,968.8	-11.3%
Uranium Enrichment	$152.7	$163.6	$100.0	-38.9%
Clean Coal Technology	$361.4	$390.0	$500.0	28.2%
Bonneville Power Administration	$18.1	$19.8	$20.0	1.0%
Environmental Restoration	$168.8	$223.9	$223.2	-0.3%
TOTAL, DOE R&D[3]	$7,338.7	$8,251.3	$8,092.2	-1.9%

Table II-12. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
TOTAL Conduct of R&D	$6,129.2	$6,550.0	$6,564.0	0.2%
TOTAL R&D Facilities	$1,209.5	$1,701.3	$1,528.2	-10.2%

Source: Agency budget justification and supporting documents.

[1] Includes conduct of R&D, plant and capital equipment.

[2] Formerly the Solar Energy Research Institute.

[3] When this report went to press it was uncertain whether DOE classified certain programs as R&D. Thus, this table may understate DOE's R&D by the following amounts: $33 million in FY 1991, $53.0 million in FY 1992, and $54.0 million in FY 1993.

[4] FY 1993 estimate excludes the obligation of $233 million which the Administration expects to finance through payments from non-federal participants.

Table II-13. Department of Energy Funding to Multiprogram National Laboratories by Program Type, FY 1993 (obligations in millions)

	Energy Supply R&D	Atomic Energy Defense Activities	General Science & Research	Fossil Energy R&D	Energy Conser-vation	Other[1]	Total
Ames Laboratory	$21.0	$0.2	$1.2	$0.0	$0.3	$0.0	$22.7
(Change from FY 92)	(1.4)	(0.0)	(0.0)	(0.7)	(0.0)	--	(0.7)
Argonne National Laboratory	385.6	8.0	23.3	2.4	10.6	10.4	440.4
(Change from FY 92)	(67.5)	(0.3)	(-1.9)	(-1.9)	(1.5)	(-1.8)	(63.7)
Brookhaven National Laboratory	134.4	4.7	178.2	0.0	1.6	9.6	328.5
(Change from FY 92)	(16.9)	(0.0)	(17.6)	(-0.4)	(-0.1)	(0.1)	(34.1)
Idaho Nat'l Engineering Laboratory	41.1	155.8	0.4	1.4	4.1	0.0	202.8
(Change from FY 92)	(2.9)	(9.9)	(0.0)	(-1.2)	(-0.8)	--	(10.8)
Lawrence Berkeley Laboratory	115.7	0.0	58.0	1.4	16.5	16.9	208.6
(Change from FY 92)	(7.9)	--	(-11.6)	(-0.5)	(4.2)	(2.3)	(2.2)
Lawrence Livermore Laboratory	89.1	541.8	1.7	3.2	0.5	97.1	733.3
(Change from FY 92)	(10.2)	(38.4)	(-0.3)	(-2.1)	(0.0)	(-58.6)	(-12.3)
Los Alamos Scientific Laboratory	75.9	568.3	58.6	0.0	8.1	15.0	725.9
(Change from FY 92)	(-0.8)	(8.2)	(1.8)	(-0.5)	(2.5)	(0.8)	(12.0)
Oak Ridge National Laboratory	201.3	13.7	12.8	4.0	47.0	7.5	286.3
(Change from FY 92)	(4.6)	(1.3)	(-2.3)	(-1.6)	(2.1)	(-0.7)	(3.5)

Table II-13. (continued)

	Energy Supply R&D	Atomic Energy Defense Activities	General Science & Research	Fossil Energy R&D	Energy Conser-vation	Other[1]	Total
Pacific Northwest Laboratory	75.7	18.0	0.1	0.5	9.9	3.9	108.0
(Change from FY 92)	(9.8)	(-0.2)	(0.0)	(-1.0)	(-2.4)	(0.2)	(6.4)
Sandia Laboratories	71.5	775.3	0.0	5.3	12.1	19.6	883.8
(Change from FY 92)	(-1.3)	(-51.4)	--	(-3.1)	(6.0)	(0.2)	(-49.6)
Savannah River Laboratory	0.5	0.9	0.0	0.0	0.0	0.0	1.3
(Change from FY 92)	(0.0)	(0.1)	--	--	--	--	(0.1)
Westinghouse Hanford Company	5.0	15.5	0.0	0.1	0.0	0.0	20.6
(Change from FY 92)	(-3.2)	(0.1)	--	(0.0)	--	--	(-3.0)
TOTAL	$1,216.8	$2,102.1	$334.3	$18.3	$110.6	$180.0	$3,962.2
(Change from FY 92)	($115.9)	($6.9)	($3.3)	(-$12.9)	($13.0)	(-$57.5)	($68.6)

Source: Department of Energy, Office of Energy Research. (See Table II-12 for breakdown of program types.)

[1] "Other" includes: Nuclear Waste Fund, Departmental Administration, Clean Coal Technology, the Strategic Petroleum Reserve (Sandia only), and Uranium Enrichment.

Table II-14. R&D in the National Aeronautics and Space Administration (budget authority in millions)

	FY1 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Research & Development Appropriation:				
Space Station	$1,900.0	$2,028.9	$2,250.0	10.9%
Space Transportation Capability Development	602.5	731.5	863.7	18.1%
Space Science and Applications	2,431.1	2,633.5	2,887.0	9.6%
Physics and Astronomy	969.2	1,047.3	1,113.5	6.3%
Life Sciences	137.4	145.8	177.2	21.5%
Planetary Exploration	473.7	535.6	487.2	-9.0%
Earth Science and Applications	662.3	738.5	868.5	17.6%
Materials Processing	102.3	118.8	195.3	64.4%
Communications	50.5	12.5	4.6	-63.2%
Information Systems	35.7	35.0	40.7	16.3%
Research Operations Support	[92.4]	82.3	98.0	19.1%
Commercial Programs	88.0	148.6	171.6	15.5%
Technology Utilization	24.4	32.5	31.7	-2.5%
Commercial Use of Space	63.6	116.1	139.9	20.5%
Aeronautics Research and Technology	512.0	774.6	890.2	14.9%
Transatmospheric Research and Technology	95.0	20.0	80.0	300.0%
Space Research and Technology	286.9	309.0	332.0	7.4%
Space Exploration	[3.5]	[5.0]	31.8	[5.4%]
Safety, Reliability and Quality Assurance	33.0	33.6	32.5	-3.3%
Tracking and Advanced Data Systems	20.0	22.0	23.2	5.5%
Academic Programs	55.1	66.8	71.4	6.9%
TOTAL, R&D Appropriation	$6,023.5	$6,850.8	$7,731.4	12.9%

Table II-14. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
TOTAL, R&D in Other Appropriations[1]	2,100.4	1,710.8	1,577.0	-7.8%
TOTAL, NASA R&D	$8,123.9	$8,561.6	$9,308.4	8.7%
Conduct of R&D	7,348.5	7,706.4	8,672.6	12.5%
R&D Facilities	775.4	855.2	635.8	-25.7%
TOTAL, NASA Operations[2]	5,744.2	5,758.5	5,684.6	-1.3%
TOTAL, NASA Budget Authority	$13,868.1	$14,320.1	$14,993.0	4.7%
Detail of R&D Appropriation:				
Space Station	$1,900.0	$2,028.9	$2,250.0	10.9%
Space Transportation Capability Development				
Spacelab	$129.3	$96.0	$122.6	27.7%
Upper Stages	82.5	62.3	[56.5]	-100.0%
Engineering and Technical Base	208.5	215.8	224.2	3.9%
Payload Operations and Support Equipment	101.2	119.1	153.6	29.0%
Advanced Programs	35.2	39.3	57.7	46.8%
New Launch System	23.9	38.0	125.0	228.9%
Tethered Satellite System	21.9	16.4	3.4	-79.3%
Research Operations Support[3]	[169.047]	144.6	177.2	22.5%
TOTAL, Space Transportation Capability Development	$602.5	$731.5	$863.7	18.1%

Table II-14. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Physics and Astronomy				
Gamma Ray Observation Development	$22.0	--	--	--
Global Geospace Science	96.6	75.3	60.1	-20.2%
Advanced X-Ray Astrophysics Facility	101.2	151.0	174.0	15.2%
Payload and Instrument Development	92.6	116.5	78.2	-32.9%
Shuttle/Spacelab Payload Mission Management and Integration	88.8	88.0	101.1	14.9%
Space Station Integrated Planning	3.0	--	--	--
Explorer Development	99.8	105.0	112.5	7.1%
Mission Operations and Data Analysis	311.9	380.8	440.9	15.8%
Research and Analysis	98.3	70.5	81.4	15.5%
Suborbital Program	55.0	60.2	65.3	8.5%
TOTAL, Physics and Astronomy	$969.2	$1,047.3	$1,113.5	6.3%
Planetary Exploration				
Ulysses International Solar Polar Mission	$2.8	--	--	--
Mars Observer	88.5	76.9	--	-100.0%
Mars Balloon Relay Experiment	1.497	1.2	--	-100.0%
Comet Rendezvous/Asteroid Flyby	143.0	210.7	210.0	-0.3%
Mission Operations and Data Analysis	170.152	156.1	170.3	9.1%
Research and Analysis	67.766	90.7	106.9	17.9%
TOTAL, Planetary Exploration	$473.7	$535.6	$487.2	-9.0%

Table II-14. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Life Sciences				
Human Flight and Systems Engineering	$58.3	$70.1	$71.4	1.9%
Space Biological Systems	22.8	14.6	18.3	25.3%
Centrifuge	[5.1]	[8.2]	18.4	[124.4%]
Radiation Biology Initiative/Lifesat	[2.0]	--	--	--
Search for Extraterrestrial Intelligence	11.5	13.5	13.5	0.0%
Research and Analysis	44.8	47.6	55.6	16.8%
TOTAL, Life Sciences	$137.4	$145.8	$177.2	21.5%
Earth Science and Applications				
Earth Observing System (EOS)	$150.6	$184.4	$308.4	67.2%
EOS Data Information System	36.0	82.6	82.6	0.0%
Earth Probes/Scatterometer	51.7	92.8	88.9	-4.2%
Upper Atmosphere Research Satellite	62.0	--	--	--
Ocean Topography Experiment	80.4	59.9	--	-100.0%
Payload Instrument Development	49.1	39.6	49.4	24.7%
Mission Operations and Data Analysis	39.4	83.8	142.1	69.6%
Interdisciplinary Research	12.4	2.5	2.6	4.0%
Modeling and Data Analysis	44.3	49.0	45.0	-8.2%
Process Studies	116.2	123.6	126.6	2.4%
Airborne Science and Applications	20.2	20.3	22.9	12.8%
TOTAL, Earth Science and Applications	$662.3	$738.5	$868.5	17.6%

Table II-14. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Other Space Applications				
Materials Processing in Space	$102.3	$118.8	$195.3	64.4%
Advanced Communications Technology Satellite	34.0	11.2	3.6	-67.9%
Search and Rescue	1.4	1.3	1.0	-23.1%
Advanced Communications Research[4]	11.4	[15.3]	[16.5]	[7.8%]
Other Communications[5]	3.7	[11.6]	[13.6]	[17.2%]
Information Systems R&D	35.7	35.0	40.7	16.3%
Research Operations Support	[92.4]	82.3	98.0	19.1%
TOTAL, Other Space Applications	$188.5	$248.6	$338.6	36.2%
Commercial Programs				
Technology Utilization	$24.4	$32.5	$31.7	-2.5%
Commercial Use of Space	$63.6	$116.1	$139.9	20.5%
TOTAL, Commercial Programs	$88.0	$148.6	$171.6	15.5%
Aeronautics Technology				
Research and Technology Base	$336.4	$360.7	$394.0	9.2%
Systems Technology Programs	175.6	203.8	253.0	24.1%
Research Operations Support[3]	[235.3]	210.1	243.2	15.8%
TOTAL, Aeronautics Technology	$512.0	$774.6	$890.2	14.9%

Table II-14. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Space Research and Technology				
Research and Technology Base	$125.7	$141.8	$173.8	22.6%
In-space Experiments Technology Program[6]	11.2	15.5	--	-100.0%
Civilian Space Technology Initiative	119.0	79.8	158.2	98.2%
Exploration Technology[7]	27.5	29.0	--	-100.0%
Space Automation and Telerobotics[7]	[128.5]	37.9	--	-100.0%
Exploration Mission Studies[8]	3.5	5.0	--	-100.0%
TOTAL, Space Research and Technology	$286.8	$309.0	$332.0	7.4%
Space Exploration[8]	[3.5]	[5.0]	31.8	[5.4%]
Transatmospheric R&T/Space Plane	95.0	20.0	80.0	300.0%
Safety, Reliability and Quality Assurance	$33.0	$33.6	$32.5	-3.3%
Tracking and Advanced Data Systems	$20.0	$22.0	$23.2	5.5%
Academic Programs	55.1	66.8	71.4	6.9%

Source: OMB data for R&D for FY 1993 and agency budget justification. Figures in brackets represent funding for the activity included elsewhere in the budget in prior years.

[1] R&D funding in "Research and Program Management" and "Construction of Facilities" accounts.

[2] Includes Space Flight, Control and Data Communications funding and the non-R&D portion of the RMP account.

[3] Prior to FY 1992, these activities were funded in the Research and Program Management (RPM) appropriation.

[4] Beginning in FY 1992, these activities are included under Aeronautics and Space Technology.

[5] Beginning in FY 1992, these activities have been transferred to Commercial Use of Space.

[6] Transferred to Research and Technology Base in FY 1993.

[7] Transferred to CTSI in FY 1993.

[8] Activities restructured in FY 1993 as new line item.

Table II-15. R&D in the Department of Agriculture (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Agricultural Research Service	$672.0	$719.0	$721.7	0.4%
Cooperative State Research Service	439.6	494.7	404.3	-18.3%
National Research Initiative[1]	73.0	97.5	150.0	53.8%
Agricultural Experiment Stations	162.3	168.8	168.8	0.0%
Cooperative Forestry Research	17.9	18.5	15.8	-14.6%
1890 Colleges and Tuskegee	26.3	27.4	28.4	3.6%
1990 Capacity Building Grants	5.1	5.1	5.7	11.8%
Special Research Grants	62.6	74.5	28.9	-61.2%
Animal Health and Disease Research	5.5	5.5	0.0	-100.0%
Administration	8.6	9.4	2.2	-76.6%
Aquaculture Research Centers	3.7	4.0	0.0	-100.0%
Alternative Crops Research	1.2	1.2	0.0	-100.0%
International Trade Centers	3.1	0.0	0.0	0.0%
Sustainable Agriculture	6.7	6.7	4.5	-32.8%
Critical Materials	0.8	0.4	0.0	-100.0%
State Agricultural Weather Information System	0.0	0.4	0.0	-100.0%
Buildings and Facilities	62.8	75.3	0.0	-100.0%
Forest Service	186.0	184.1	173.7	-5.6%
Economics Research Service	54.4	58.7	60.4	2.9%
Agricultural Cooperative Service	2.8	3.5	3.1	-11.4%
Agricultural Marketing Service	4.2	4.7	4.3	-8.5%

Table II-15. (continued)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Office of International Cooperation and Development	2.6	1.5	1.5	0.0%
Human Nutrition Information Service	9.9	10.7	13.7	28.0%
National Agricultural Statistics Service	3.2	3.4	3.4	0.0%
Animal and Plant Inspection Service	15.7	16.7	16.7	0.0%
Federal Grain Inspection Service	0.7	0.7	0.4	-42.9%
TOTAL, USDA R&D	$1,391.1	$1,497.7	$1,403.2	-6.3%
Conduct of R&D	$1,226.4	$1,328.2	$1,332.3	0.3%
R&D Facilities	$164.7	$169.5	$70.9	-58.2%

Source: "OMB data for R&D for FY 1993 and agency budget justification.

[1] Formerly "Competitive Grants."

Table II-16. R&D in the Environmental Protection Agency by Media (budget authority in millions)

MEDIA	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
R&D in Salaries & Expenses & R&D Appropriations:				
Air Quality	$64.9	$90.0	$95.8	6.5%
Acid Deposition[1]	14.0	13.4	14.9	10.5%
Global Change[2]	22.1	23.3	25.7	10.4%
Water Quality	28.0	30.6	32.7	6.7%
Drinking Water	18.9	22.1	21.9	-0.9%
Hazardous Waste[3]	39.9	47.7	39.8	-16.6%
Pesticides	11.9	14.5	15.8	8.8%
Radiation	3.9	3.5	4.1	16.5%
Multimedia	120.9	153.7	170.8	11.2%
Toxic Substances	25.5	25.3	26.8	5.8%
Management and Support	5.1	5.3	5.4	1.2%

Table II-16. (continued)

MEDIA	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-92
R&D in Other Appropriations:				
Superfund	83.8	66.8	68.9	3.2%
Leaking Underground Storage Tanks	0.8	0.8	0.8	0.0%
Oil Spill Response[3]	[2.0]	[2.5]	2.6	[4.0%]
Buildings and Facilities	19.2	5.0	2.5	-50.0%
TOTAL, EPA R&D	$458.9	$502.0	$528.4	5.3%
Conduct of R&D	$439.7	$497.0	$525.9	5.8%
R&D Facilities	$19.2	$5.0	$2.5	-50.0%

Source: Agency budget justification and supporting documents.

[1] Formerly named "Energy."

[2] Formerly included under Air Quality.

[3] Beginning in FY 1993, R&D on oil spills will be funded through the Oil Spill Response Trust Fund. Brackets denote funding included in other line items in prior years.

Table II-17. R&D in the Department of the Interior (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
U.S. Geological Survey	$359.9	$366.7	$329.3	-10.2%
Bureau of Mines	109.1	82.7	75.3	-8.9%
Fish and Wildlife Service	106.1	86.1	89.2	3.6%
National Park Service	25.2	29.0	29.5	1.7%
Bureau of Reclamation	9.5	11.4	10.3	-9.6%
Bureau of Land Management	5.3	10.7	7.7	-28.0%
Office of Surface Mining Reclamation and Enforcement	1.3	1.4	1.6	14.3%
Minerals Management Service	2.9	6.0	6.0	0.0%
Office of the Secretary	0.7	1.1	1.6	45.5%
TOTAL, Interior R&D	$620.0	$595.1	$550.5	-7.5%
Conduct of R&D	$591.7	$582.8	$539.8	-7.4%
R&D Facilities	$28.3	$12.3	$10.7	-13.0%

Source: OMB data for R&D for FY 1993 and agency budget justification.

Table II-18. R&D in the Department of Transportation (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
Federal Aviation Administration	$244.7	$270.0	$273.9	1.4%
Federal Highway Administration	88.2	109.5	134.6	22.9%
National Highway Traffic Safety Administration	21.4	25.8	35.8	38.8%
Coast Guard	25.0	29.2	29.9	2.4%
Federal Railroad Administration	22.1	22.3	25.8	15.7%
Office of the Secretary	4.1	4.6	4.6	0.0%
Research and Special Programs Administration	2.3	2.5	2.7	8.0%
Federal Transit Administration[1]	1.6	9.4	9.4	0.0%
Maritime Administration	1.7	1.8	1.7	-5.6%
TOTAL, DOT R&D	$411.1	$474.9	$518.4	9.2%
Conduct of R&D	$392.9	$446.1	$497.5	11.5%
R&D Facilities	$18.2	$28.8	$20.9	-27.4%

Source: OMB data for R&D for FY 1993.

[1] Formerly the Urban Mass Transportation Administration.

Table II-19. R&D in the Department of Commerce (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Budget	Percent Change FY 1992-93
National Oceanic and Atmospheric Administration	$348.1	$399.4	$382.2	-4.3%
National Institute of Standards and Technology	172.3	198.5	255.2	28.6%
National Telecommunications and Information Admin.	8.3	8.3	11.4	37.3%
Bureau of the Census	6.6	6.1	5.9	-3.3%
Economic Development Administration	1.5	0.5	0.0	-100.0%
TOTAL, Commerce R&D	$536.8	$612.8	$654.7	6.8%
Conduct of R&D	$520.9	$589.6	$622.7	5.6%
R&D Facilities	$15.9	$23.2	$32.0	37.9%

Source: OMB data for R&D for FY 1993 and agency budget justifications. .

Table II-20. R&D in the Department of Education (budget authority in millions)

	FY 1991 Actual	FY 1992 Est.	FY 1993 Est.	Percent Change FY 1992-93
Rehabilition Services and Handicapped Research	$50.9	$52.4	$53.2	1.5%
Education Research and Statistics	37.6	41.1	88.8	116.1%
Handicapped Special Purpose Funds	33.1	39.0	39.0	0.0%
Special Institutions for Persons With Disabilities[1]	5.6	6.0	6.2	3.3%
Vocational and Adult Education	17.0	17.4	18.7	7.5%
Bilingual Education	1.8	1.5	1.0	-33.3%
Howard University	4.6	4.6	4.6	0.0%
International Education and Foreign Language Studies	2.0	2.4	1.7	-29.2%
Fund for the Improvement of Post Secondary Education	0.4	0.5	0.5	0.0%
All Other	9.8	7.3	3.7	-49.3%
TOTAL, Education R&D	$162.8	$172.2	$217.4	26.2%
Conduct of R&D	$158.6	$170.1	$215.3	26.6%
R&D Facilities	$4.2	$2.1	$2.1	0.0%

Source: Agency budget justification and supporting documents.

[1] R&D at Galluadet University, American Printing House for the Blind, and National Technical Institute for the Deaf, formerly included within "other."

Part III: Disciplinary Analyses

Introduction

The chapters that follow take a cross-cutting view of the FY 1993 figures for R&D to the preceding agency chapters -- summarizing the R&D prospects for some of the major scientific and engineering disciplines and research areas. In each case, the budgets of various agencies that provide support for these disciplinary areas are examined, and policy issues and funding trends are discussed in terms of their impacts on the disciplines. Tables in these chapters, on the whole, contain detail of agency R&D programs not shown in the tables that appear at the end of Part II.

Chapter 12
Physics in the FY 1993 Budget

American Institute of Physics

Richard M. Jones, Audrey T. Leath

It is difficult to characterize with a single word the Administration's support for physics research in the fiscal year 1993 budget request. The Superconducting Super Collider continues to receive large proposed increases in spending. At the same time, the National Science Foundation estimates that it will increase the number of awards for physics research by less than 1 percent over current levels. And there was no reprieve for Department of Energy physics research facilities closed during fiscal year 1992.

Physics research funding is supported by the National Science Foundation, the Department of Energy, the National Institute of Standards and Technology, and the Department of Defense. This chapter reviews the DOE, NSF, and NIST physics-related budget requests. The Department of Defense does not provide specific information on physics research; readers interested in an overview of this budget should consult the DOD chapter.

Highlights:

- Proposed budget increases for physics-related research range from a low of 0.5 percent for the DOE High Energy Physics Program to 34.4 percent for the Superconducting Super Collider.
- NSF is requesting an increase of 7.4 percent for the Physics Subactivity.

- NSF also provides funding for physics research through the Materials Research Subactivity, for which a 16.6 percent increase has been requested.

- The NSF budget request allocates $14 million for the National High Magnetic Field Laboratory and $48 million for the Laser Interferometer Gravitational Wave Observatory.

- The National Institute of Standards and Technology proposed budget includes an 8.1 percent increase for physics intramural research, as well as an 11.2 percent increase for Materials Science and Engineering research.

Department of Energy:

The Department of Energy supports physics research within the following programs: High Energy Physics, Nuclear Physics, Superconducting Super Collider, Fusion Energy, and Basic Energy Sciences. Physics received little attention in the Secretary of Energy's budget briefing this year; the major challenges for DOE involve downsizing its nuclear weapons production complex, implementing the National Energy Strategy, and performing environmental clean-up and waste management. Funding within physics programs varied widely. DOE contends that the tight budget makes it impossible to fund everything; the emphasis is on operating the highest priority facilities while closing others, if necessary, to maintain excellence in scientific research.

High Energy Physics

Of DOE's physics programs, High Energy Physics felt the squeeze the most. Its fiscal year 1993 request of $630.9 million is an increase of only $2.9 million, or 0.5 percent, an amount not even keeping pace with inflation.

DOE's budget submission to Congress for high energy physics notes that "high energy physics contributes to the nation's economic competitiveness," and stresses the field's impact on university research:

"It is essential that the capability of university scientists to participate effectively in world forefront experiments be maintained."

The three high energy physics accelerator centers supported by DOE are Fermilab, the Stanford Linear Accelerator Center (SLAC), and the Alternating Gradient Synchrotron (AGS) at Brookhaven. DOE states that "operations of the forefront research capabilities of the SLC [Stanford Linear Collider] and of the Tevatron accelerator/collider [at Fermilab] will be conducted at the maximum reasonable level." One of the main projects in the fiscal year 1993 budget is the upgrade of the Main Injector at Fermilab, which receives $30 million, up from $15 million in fiscal year 1992.

Construction of the SSC, although funded as a separate program, remains the highest priority of the High Energy community. The budget notes that "basic research support for the physicists planning and preparing experiments to be conducted at the SSC will continue to be an integral part of the High Energy Physics program presented in this budget submission."

Superconducting Super Collider

A total of $650.0 million is requested for the SSC, an increase of $166.3 million, or 34.4 percent, over the fiscal year 1992 appropriation. The SSC is viewed as the future of U.S. high energy physics. The DOE budget submission calls the SSC "both a symbol of the nation's commitment to scientific leadership in this century and the next, and an instrument by which U.S. leadership can be maintained."

Of the $650.0 million requested, $116.8 million will go toward R&D on superconducting magnets, accelerator technical systems, detector subsystems, general laboratory operating costs and program direction costs. Funding of $63.0 million will go to capital equipment funds for detector and accelerator systems, general laboratory equipment and instrumentation. Another $470.2 million in federal construction funds is designated for system and facilities design, fabrication of injector and collider technical systems and components, on-site construction of conventional facilities and project management.

Non-federal contributions are also expected from the State of Texas and foreign contributors. The budget says that "discussions are underway with potential foreign partners to develop specific proposals for participation and to begin negotiating agreements on the magnitude and type of contributions. International contributions to accelerator construction are expected in fiscal year 1993 in the form of technical subsystems and components."

The budget shows funding projections for this controversial program through fiscal year 1999, with the budget cresting at $1,094.5 million in fiscal year 1996.

Nuclear Physics

Nuclear Physics also receives an increase lower than the inflation rate in the proposed budget. DOE's request of $363.5 million is only $9.1 million, or 2.6 percent, over fiscal year 1992.

Several facilities are slated for termination in fiscal year 1993 while others are under completion. DOE states that "the strategy of the program is to address the most pressing scientific questions in nuclear physics with new theories, equipment and facilities while maintaining an effective balance between competing and diverse program elements. . . . As part of adjusting to constrained funding profiles, operations of the Holifield Heavy Ion Research Facility at Oak Ridge National Laboratory, for nuclear physics research, and the Fast Neutron Generator at Argonne National Laboratory for nuclear data measurements will be terminated." A transition plan will be developed "to permit an orderly phaseout" of the Bevelac at Lawrence Berkeley and LAMPF [Los Alamos Meson Physics Facility] after experiments approved for fiscal year 1993 are completed.

Components of the Nuclear Physics program would experience the following funding changes:

- *Medium Energy Nuclear Physics* would increase by 3.1 percent to $111.4 million.

- *Heavy Ion Nuclear Physics* would drop 9.1 percent to $67.9 million.

- *Low Energy Nuclear Physics* would decrease 8.1 percent to $26.1 million.

- *Nuclear Theory* would grow by 5.7 percent to $14.8 million.

The budget submission places special emphasis on use of the upgraded electron beams at MIT and the Tandem/AGS high energy heavy ion beams at Brookhaven National Laboratory. Priorities within the program will be set to accommodate students and postdoctoral fellows in nuclear physics and to reflect more accurately the highest program priorities and new scientific areas in physics.

The Relativistic Heavy Ion Collider (RHIC) at Brookhaven will be the largest construction project in fiscal year 1993. The other high priority construction project within Nuclear Physics, the Continuous Electron Beam Accelerator Facility (CEBAF), is nearly complete and its construction funds will be ramping down.

Fusion Energy

The Department of Energy's fiscal year 1993 request for Fusion Energy is $359.7 million, an increase of $21.3 million, or 6.0 percent, over fiscal year 1992. However, recent funding increases have not been enough to keep the program on track.

According to DOE, "fiscal constraints have required the program to prematurely narrow its focus to the tokamak concept, including tokamak improvement activities, and to eliminate major alternate magnetic confinement program elements. At least five experimental programs have been closed in fiscal years 1991 and 1992. The Confinement Physics Research Facility reversed field pinch under construction at Los Alamos National Laboratory has been canceled. The Advanced Toroidal Facility stellarator at Oak Ridge National Laboratory is being mothballed. The recently dedicated Large S Experiment at Spectra Technology and the Field Reversed Experiment-C compact torus at Los Alamos have been shut down. Restart of the Princeton Beta Experiment advanced tokamak at Princeton Plasma Physics Laboratory did not take place in fiscal year 1991 as originally planned, but was instead delayed to fiscal year 1992. In addition, with continued constraints in fiscal year 1992, it will be necessary to prematurely shut down the Microwave Tokamak Experiment at LLNL [Lawrence Livermore National Laboratory] in late fiscal year 1992."

Another result of insufficient funding will be the cancellation of the Burning Plasma Experiment (BPX). Tokamak research will instead focus on the U.S.'s role in ITER, the International Thermonuclear Experimental Reactor, a partnership between the U.S., Russia, Japan and Europe.

In addition to its concentration on magnetic fusion, the budget submission states that "an Inertial Fusion Energy program, constrained to one driver concept and to budget-paced technology development, has been initiated. This program will rely on continuing development of target physics within Defense Programs. The heavy ion driver, successfully conceived through Defense Programs and Basic Energy Sciences activities, will be extended and tested."

Basic Energy Sciences

The fiscal year 1993 budget proposed for Basic Energy Sciences (BES) is $813.9 million. This is a growth of $49.2 million, or 6.4 percent, over fiscal year 1992.

Under the proposed budget, components of BES would experience the following changes:

- *Materials Sciences* would increase by 12.9 percent to $290.2 million.

- *Chemical Sciences* would grow 10.8 percent to $175.4 million.

- *Applied Mathematics* would increase 11.7 percent to $91.0 million.

- *Engineering and Geosciences* would increase 10.5 percent to $39.5 million.

- *Energy Biosciences* would grow 11.7 percent to $27.6 million.

- *Advanced Energy Projects* would decrease 78.3 percent to $11.9 million.

DOE notes that "this budget is designed to balance: research and facility needs; university and laboratory supported research; core research and enhanced activities; and ensure that the BES program is responsive to the overall NES [National Energy Strategy] goals." BES research emphasizes the Presidential initiatives originating through the FCCSET process: Materials Research, Biotechnology, High Performance Computing, and Math and Science Education, as well as strengthening small science at DOE labs and universities.

National Science Foundation:

The majority of the National Science Foundation's support for physics is in three subactivities: physics, materials research, and major research equipment. The budget for the physics subactivity will increase by 7.4 percent; the materials research budget by 16.6 percent. Continuing funding is requested for the National High Magnetic Field Laboratory and the Laser Interferometer Gravitational Wave Observatory.

Physics Subactivity Support

As was true in previous budget requests, the Department of Energy provides much greater support for physics research than does NSF. The Administration's budget request for the SSC alone is more than twice that of the $148.6 million NSF request for the physics subactivity.

NSF support is of particular importance to research universities. Although only 8 percent of all federal elementary particle physics money flows from NSF, it provides approximately one-third of total federal support for academic research in the field. A similar relationship exists for nuclear physics research.

The Physics Subactivity supports research in five program elements. Proposed budget increases are as follows:

- *Elementary Particle Physics* funding would increase by 7.9 percent to $48.4 million.

- *Nuclear Sciences* funding would increase by 7.9 percent to $48.4 million.

- *Atomic, Molecular, Optical Physics* support would increase by 6.2 percent to $19.0 million.

- *Theoretical Physics* funding is up 4.2 percent to $20.8 million.

- *Gravitational Physics* support is up 10.6 percent to $11.9 million.

The NSF budget request highlights an increment of $0.8 million for computational physics as a component of the FCCSET High Performance Computing and Communications initiative, as well as $1.1 million for experimental gravitation and for gravity wave detection. NSF requests $5.0 million for the upgrading of major facilities, including an ultra-high energy cosmic detector and spectrometer detectors at the Indiana University Cyclotron Facility and the Michigan State Cyclotron Facility.

The Administration emphasizes increasing support for individual investigators and small groups in the fiscal year 1993 budget. However, the NSF budget document estimates five more awards will be made in fiscal year 1993, resulting in the support of five additional senior scientists and five additional graduate students.

Materials Research Subactivity Support

NSF also funds physics research in its Materials Research Subactivity "to advance the fundamental understanding of the physics and chemistry of materials. . . ." Stressing the interdisciplinary nature of materials research, the budget document notes the importance of condensed matter physics in this area. NSF provides approximately 50 percent of all federal support for university-based materials research activity.

Within this Subactivity, NSF is requesting the following:

- *Materials Research Project Support* is up 24.5 percent to $96.4 million.

- *Materials Research Laboratories and Groups* funding would increase 7.2 percent to $51.4 million.

- *National Facilities and Instrumentation* would receive an 8.2 percent increase to $19.7 million.

Not all of the $167.5 million requested for fiscal year 1993 would be allocated for physics-related research. Of the $23.9 million requested increase, the FCCSET Advanced Materials and Processing Program would receive $18.9 million. This initiative will focus on "the synthesis and processing of advanced materials including electronic, optical, photonic, biomolecular, structural, magnetic, and superconducting materials. . . ."

Major Research Equipment Subactivity

Physics-related research is also supported through the Major Research Equipment Subactivity. Two projects are of direct interest to the physics community:

- *National High Magnetic Field Laboratory* funding of $14.0 million would be used for the construction and development of additional magnets, additional instrumentation, establishment of an in-house research program, and initial user operations. The cost of this facility is estimated at $140.0 million, with more than half to be provided by the State of Florida.

- *Laser Interferometer Gravitational Wave Observatory (LIGO)* funding of $48 million is requested for fiscal year 1993. This money would be allocated for civil design work, site preparation, and vacuum system component fabrication.

The National Institute of Standards and Technology:

The fiscal year 1993 budget request for the Department of Commerce's National Institute of Standards and Technology (NIST) totals $310.7 million, an increase of $64.0 million, or 25.9 percent, over fiscal year 1992.

This is the third year of double-digit growth for the institute, a turnabout from 20 years of nearly flat budgets. The President's fiscal year 1992 budget projected a doubling of the NIST budget by 1996.

NIST's Intramural Research increases by 15.6 percent to $201.9 million. New projects within the research program include technology development in advanced semiconductors, magnetic media, composites and other advanced materials, chemical processing techniques, and computer and telecommunications technologies. Physics research, which receives an increase of 8.1 percent to $28.2 million, will be directed toward "investigations into the physics and chemistry of atomic clusters and nanometer-sized structures," according to the budget summary.

Other intramural research areas also receive significant increases. Materials Science and Engineering increases 11.4 percent to $38.6 million. Manufacturing Engineering receives a 36.9 percent increase to $13.1 million. Computer systems increases by 47.6 percent to $17.5 million, while Applied Math and Computing grows 4.7 percent to $6.8 million.

Chapter 13

Astronomy in the FY 1993 Budget

American Astronomical Society

Peter B. Boyce

I. Highlights of the Astronomy Budget

This is an enormously exciting time for astronomy. Operating missions and telescopes are producing remarkable data and funding is generally adequate to enable this to continue. Some eagerly awaited major projects are nearing completion. But the construction of other long-planned projects has been cancelled or severely curtailed.

It is important to remember that this is only the asking budget. Last year the astronomy budget drew considerable congressional attention; the fate of several astronomy projects was not settled until the final conference committee met. Congressional action was both positive (adding back the Shuttle Test of Relativity mission which NASA had eliminated) and negative [cutting out all funding for the development of the Space Infrared Telescope Facility (SIRTF)]. We can expect that Congress will play close attention to the astronomy budget again this year.

- Within NSF, a special budget line for Major Research Instruments contains $17 million for continuing the construction of a pair of modern 8-meter optical telescopes with British and Canadian participation and $48 million for construction of a Laser Interferometer Gravitational Wave Observatory (LIGO).

- A substantial effort will be made in NSF to rebuild the infrastructure, shore up the program of grants for individual investigators and proceed with a program of using adaptive optics techniques to sharpen the images obtained with ground-based telescopes.

- NASA's Comet Rendezvous/Asteroid Flyby (CRAF) mission has been canceled.

- Spending on NASA's Advanced X-Ray Astronomy Facility (AXAF) has been capped at $174 million, forcing a 13-month delay in the launch date.

- NASA's budget has minimally adequate funding for operating existing missions.

II. Introduction

As in previous years, we will limit our analysis of the astronomy budget to the two agencies which provide over three quarters of the federal funding for astronomical research, NASA and NSF. These agencies supply virtually all of the federal funding for individual research grants. Other agencies, such as the Smithsonian Institution, the Department of Defense, the Department of Energy, etc., also fund research of interest to astronomy, but they play a smaller role in the picture of federal support for astronomy. In general, their funding is restricted to support of their own research projects.

III. Astronomy in the NASA Budget

Astronomy in NASA is included in both their Physics and Astronomy and their Planetary Exploration programs. Physics and Astronomy, however, also includes other space physics programs, making it nearly impossible to separate the funding for astronomy from the other programs under this heading, such as Plasma Physics.

The NASA budget tables are given elsewhere in this volume. The following NASA budget lines may need explanation:

Shuttle/Spacelab Payload Mission Management & Integration provides support for the planning, integration and execution of all Spacelab and attached shuttle payloads. This includes payload specialist training, payload flight operations, and data dissemination to the experimenters.

Payload and Instrument Development is designed to accommodate development of specific instruments to be flown on the shuttle, as free-flyers or on foreign flights.

Mission Operations and Data Analysis supports the operating costs of current missions and funds the analysis of data from current and past missions. The entire scientific output of a mission is supported by these funds.

Research and Analysis supports general research relevant to NASA's missions and provides the advanced technology development needed to plan future missions. Funding for early exploratory work on the difficult, pacing items for future missions, such as the Space Infrared Telescope Facility (SIRTF), fall in this budget line, as do the Astrophysics Theory Program and grants to individual investigators.

Suborbital Programs supports the flights of aircraft, balloons and rockets. These vehicles provide low-cost platforms for developing instrumentation and provide frequent opportunities for making vital supporting observations.

Despite growing by 9.4 percent, the FY 1993 NASA budget for space science is one of retrenchment. Seemingly acknowledging the impossibility of completing all the present missions, the budget cancels a major planetary mission and a medium astrophysics mission and places strong constraints upon the growth being allowed for projects under way.

- The Hubble Space Telescope (HST) is now producing excellent science as the astronomers are learning how to deal with the spherical aberration. Operations are adequately funded. Plans for a repair and refurbishment mission are proceeding as is the development of the next generation of instruments.

- The CRAF mission, a key element of the solar system exploration strategy, has been canceled.

- Although the AXAF project produced a pair of excellent mirrors within the time mandated by Congress, the project has been capped at $174 million, which results in a 13-month delay in the launch date. At this rate of funding,it will be difficult to complete the mission within a reasonable time frame.

- The Shuttle Test of Relativity (STORE) mission has been canceled.

- The Mission Operations and Data Analysis line of the Physics and Astronomy program is again increased to support scientific use of data from various science missions.

- The Magellan mission is in orbit, producing spectacular radar maps of Venus. However, there is not sufficient money in the mission operations line for the extended mission needed to complete a scientifically valuable set of stereo maps of the planet's surface.

- The Mars Observer mission is on schedule for a 1993 launch. Operation of the mission is adequately funded.

- The Research and Analysis base in Planetary Exploration, upon which the community of individual researchers depends, will increase for the second straight year, from $91 to $107 million. This includes a contribution toward the construction of an advanced technology ten-meter telescope for important ground-based observations in support of the major space missions to the planets.

- The small explorer program will come to fruition with the launch of the first of three university-class missions. The Submillimeter Wave Astronomy Satellite, the only small explorer for astrophysics, is scheduled for a 1995 launch.

- The Extreme Ultraviolet Explorer is scheduled for launch in May. Construction of the X-Ray Timing Explorer will continue, with launch scheduled in 1996.

IV. Astronomy in the NSF Budget

Astronomy support at NSF has a proposed 7 percent increase, second smallest of all the divisions within the Directorate for Mathematics and Physical Sciences. Within the National Science Foundation, most astronomical research is supported within the Division of Astronomical Sciences. The support for astronomical research in other divisions is not specifically enumerated and is difficult to separate out. The budget trends for the Division of Astronomical Sciences are indicative of the NSF support of astronomy.

Through contractors, NSF operates three National Observatories that are available to qualified scientists under an extensive visitor, use program. The National Observatories have major telescopes and some smaller instruments that have a long history of productive use. Under Astronomy Research Support, NSF has a program of peer-reviewed research grants to individual investigators and to research groups located at universities and research observatories.

The NSF FY 1992 budget table for astronomy is given below. The significant aspects are as follows:

- NSF will provide $17 million to continue construction of two modern 8-meter optical telescopes, one in each hemisphere.

The northern hemisphere telescope will be optimized for operation in the infrared in accordance with the Astronomy and Astrophysics Survey Committee recommendation. The project depends upon foreign participation for half the cost. British and Canadian participation has been secured for 35 percent of the cost. The remaining 10 percent is expected to be obtained this year.

- NRAO will complete the construction of the Very Long Baseline Array in 1992. NRAO will receive substantial funding for the restoration of the physical plant. Particular attention will be paid to the replacement of the deteriorating railroad ties and repair of the antenna transporter at the Very Long Baseline Interferometer. Construction of the 100-meter diameter Green Bank Telescope will continue, using funds supplied in previous years.

- At NAIC, an upgrade of the Arecibo radio telescope will continue as a joint project with NASA. NSF will supply upgrade funds of $4.4 million in FY 1993. The upgrade includes the design and construction of a highly efficient, all-frequency secondary mirror and the erection of a ground screen to reduce the effects of spurious radio signals. The expected 3-to 10-fold improvement in the world's most sensitive radio telescope will keep this venerable instrument competitive for the next decade.

- The 3.5 percent increase for NOAO operating funds will fall below the inflation rate, forcing cuts in programs and further delay of needed maintenance. The Cerro Tololo Interamerican Observatory in Chile is in particular trouble, being severely pinched by inflation and exchange rate problems in that country.

- The Astronomy Project Support Section, which funds the university grants, will increase by 9.5 percent. Last year, in response to a specific congressional recommendation, this program grew by 12 percent, specifically to allow an increase in the size of individual grants and to support a program of active optics designed to remove some of the deleterious effects of the earth's atmosphere. An effort will be made to continue these trends.

Within the Astronomy Project Support Section, the distribution of money among the programs is driven by proposal pressure and by transfer of responsibility for the larger grants from program to program as the emphasis shifts from instrumentation to research on stars, or to extragalactic research, or back to instrumentation. The budget requests for the individual programs of research grants generally do not reveal specific shifts in emphasis by the agency and, therefore, have not been listed separately.

NSF Astronomy Funding (in millions of dollars)

	FY 1991 Actual	FY 1992 Plan	FY 1993 Request
Total NSF Astronomy	$99.59	$112.29	$120.00
Astronomy Proj. Support	33.89	38.03	41.64
National Observatories	65.70	74.26	78.36
NAIC	8.59	10.45	11.05
NOAO	25.74	28.51	29.51
NRAO	31.37	35.30	37.90

Chapter 14

FY 1993 R&D in the Atmospheric and Oceanic Sciences

American Meteorological Society

H. Frank Eden

INTRODUCTION

The report of the interagency Committee on Earth and Environmental Sciences' coordinated, interdisciplinary U.S. Global Change Research Program for FY 1993 cross cuts many agency budgets in an interdisciplinary fashion. Tracking into the disciplines is still possible in most agencies but complicated. The program grows by 24.0 percent over the FY 1992 level to $1.37 billion in FY 1993 with the largest increases in Observations and Data Management. In NASA the Earth Sciences and Applications Division of OSSA has merged disciplinary research and analysis funds, and has responsibility for the Earth Observing System, EOS, which is a multi-disciplinary system for observing and documenting the change of many global variables. Some missions such as UARS and TOPEX can still be assigned on a disciplinary basis, but a large portion of the NASA budget cannot be so assigned in FY 1993. Accordingly, the usual cross cut table is included in this chapter but not totaled and without a NASA line. In general, however, it is clear from most agency budgets that the FY 1993 proposal requests increases for both disciplines.

National Aeronautics & Space Administration (NASA)

NASA's overall budget increases by 4.5 percent to $14.99 billion in FY 1993 and continues two major new initiatives -- a new heavy launch system to be developed jointly with DOD, and Space

Station Freedom. It continues the development of EOS and the Earth Probes. The Earth Science and Applications Program eliminates further development costs in FY 1993 for the Ocean Topography Experiment, TOPEX (to be launched in July 1992), and the Upper Atmosphere Research Satellite, UARS, (launched in September 1991). Support for the essentially completed Scatterometer is continued in the Earth Probes budget in anticipation of the instrument's flying on the Japanese ADEOS project in 1995. The old Research and Analysis disciplinary funds are now contained in Modeling and Data Analysis, Process Studies and Interdisciplinary research, and show a modest decrease to $174.2 million.

For consistency with previous years, programs that relate to upper atmosphere research now contained in the Physics and Astronomy Program are noted also. The Global Geospace Science Mission decreases to $60.1 million in FY 1993, as part of the U.S. contribution to the International Solar Terrestrial Physics Program, ISTP. Approximately 20 percent of the Research and Analysis support in the Physics and Astronomy Program is for space science. Similarly, a significant portion of the Sub Orbital Program of sounding rockets, airborne science and balloon launches is in support of atmospheric sciences.

National Science Foundation (NSF)

The overall FY 1993 request for NSF is at $3.03 billion, an increase of 17.6 percent over the FY 1992 appropriation. This continues the Administration's commitment to doubling the NSF budget over five years.

Increases in Atmospheric Sciences Project Support in FY 1993 are primarily in portions of Global Change Research (which increases by $15.8 million to $43.5 million), including enhancements for major field programs in the Global Tropospheric Chemistry Program, and the Tropical Ocean and Global Atmosphere (TOGA) program, Climate Modeling, Solar Terrestrial interactions and data management. Support for environmental responses to human activity and for High Performance Computing and Communications is also provided.

NCAR is increased by $13.3 million. This will provide for increased Global Change Research, begin the procurement of a mid-sized jet aircraft, activities in HPCC and increased costs of operations. The Upper Atmosphere Facilities program will provide enhanced support ($1.3 million) for CEDAR, and for studies of the Middle Atmosphere.

The FY 1993 increment of $27.6 million in Ocean Sciences will enhance WOCE, JGOFS, the Global Ocean Ecosystem Dynamics Program, GLOBEC, and TOGA-COARE.

In the Ocean Drilling Program, ODP, incremental support will emphasize high temperature techniques, field programs to define the regional framework for future drilling and increased analysis of logging data. Increases in the Centers and Facilities Program will support Global Change field programs, new instruments and the engineering design of an ice capable Arctic Vessel.

The above figures do not include support for the Atmospheric and Oceanic Sciences from the Division of Polar Programs. The Arctic Research Program provides support for atmospheric and oceanic research and is proposed in FY 1993 for $25.9 million. Antarctic Program support for atmospheric and oceanic research is approximately 40 percent of the Antarctic Research Program's budget of $26.7 million in FY 1993.

Department of Defense (DOD)

The budget projections for DOD are estimates based upon FY 1991 obligation, FY 1992 organizational budgets and the FY 1993 budget submission. The FY 1992 and the FY 1993 estimates are subject to change.

Army research in atmospheric sciences focuses strongly on the planetary boundary layer and support to army weapon systems.

Research includes theory and technique development to document atmospheric effects on electro-optical and infrared propagation, focusing on the battlefield environment. Research in airflow in complex terrain and atmospheric transport and diffusion addresses a broad front of Army and DOD needs. Exploratory work to evaluate new sensor technologies, such as profiler radar and lidar, continues in efforts to develop battlefield remote sensing capabilities. A centerpiece of the Army development program is the integration of weather-events and effects into the Air-Land Battle concept. A substantial effort to develop standard scenes for the evaluation and testing of weather-sensitive smart weapons is not included in budget summary, but would add about $5.0 million each year, if classed as atmospheric sciences.

The Air Force research program also focuses on a wide range of research needs. The Air Force emphasis is changing from large-scale to mesoscale dynamic modeling with a focus on air base and battlefield forecasting of clouds. On a more limited scale, research is continuing on refining the weather impact on electro-optical tactical decision aids designed to support a number of specific Air Force tactical systems and operations. In other areas, emphasis is being placed on satellite remote sensing capabilities such as the vertical sounding for temperature and water vapor, and the development of algorithms for the 3-dimensional description of cloud fields. Technology development continues in the area of advanced meteorological data processing incorporating expert systems concepts to fuse data from various sources, such as radar, satellite and other ground-based sensors.

Atmospheric science research funded by ONR consists of two primary thrusts, marine planetary boundary layer and oceanic storms. Marine boundary layer research is directed toward understanding the physical processes governing the evolution of the lowest 2 km of the atmosphere over the ocean and in coastal regions. Oceanic research has two major components, midlatitude extratropical cyclogenesis and western Pacific tropical cyclones. In other areas, efforts are underway to introduce new capabilities in meteorological and oceanographic data acquisition, processing and presentation through the introduction of the third generation

Tactical Environmental Support System (TESS-3) to major combatant ships.

Oceanographic research includes small-scale physical oceanography, mesoscale and large-scale circulation and structure, ocean geophysics (bottom characterization, thermal vents), ocean acoustics (noise sources and character, acoustic propagation), and ocean biology. Ocean circulation efforts ultimately focus on the development of eddy resolving global and regional oceanographic numerical models. The increase in FY 1993 is reflective of emphasis being placed on ocean sciences by ONR.

Not specifically included in the budget table is funding for the DOD University Research Initiative (URI) programs in atmospheric and ocean sciences. In FY 1993, approximately $3.5 million is supporting URI programs in atmospheric, ocean and space environmental sciences.

National Oceanic & Atmospheric Administration (NOAA)

The NOAA request for FY 1993 of $1.65 billion for Operations, Research and Facilities represents a modest increase over FY 1992 obligations. There is a modest reduction in the National Marine Fisheries Service, increases in the National Weather Service, and National Environmental Satellite, Data and Information Service and a reduction in Oceanic and Atmospheric Research. Significant increases are proposed for Climate and Global Change and Coastal Ocean Science.

In the National Ocean Service, the Ocean and Coastal Management program activities are reduced. The Coastal Ocean Science program increases by $5.5 million to $17.4 million.

In the National Marine Fisheries Service almost all programs have been reduced with the exception of Protected Species Management.

In Oceanic and Atmospheric Research, the Climate and Global Change program funding is $78.0 million, an increase of

$31.0 million over FY 1992; PROFS research is reduced by $0.6 million; Regional Climate Centers; Weather Modification Grants; Undersea Research; and the National Coastal R&D Institute are terminated. Sea Grant is reduced by $20.0 million to $25.0 million.

The National Weather Service is proposed for an increase of $57.4 million. NEXRAD and related procurements and acquisition of AWIPS and NOAA PORT equipment are released by $2.5 million. The Special Agricultural Weather Services are terminated.

In the National Environmental Satellite, Data, and Information Services (NESDIS), the FY 1993 request increases by approximately $99.5 million and provides for maintaining a geostationary satellite (GOES) system and a polar-orbiting satellite system. Decreases of $9.6 million are proposed for Landsat activities.

Program Support increases by approximately $8.0 million in FY 1993. NOAA ship time is reduced by $1.0 million.

Other Agencies

In DOA, the FY 1993 budget reflects a program with no significant growth aimed in part at global change issues including UV-B studies, long-term forest monitoring and ecosystem modeling and biogeochemical cycles. The budget supports basic research in climatology, upgrades to the SNOTELL joint agricultural weather facility, strengthened meteorological data handling and regional hydrological modeling and validation.

The DOE program in atmospheric sciences of the Office of Health and Environmental Research (OHER) covers over 97 percent of the total DOE budget in the atmospheric sciences. The major portion of the OHER budget involves studies dealing with global change including the atmospheric radiation measurement (ARM) program, the computer hardware advanced mathematics and model physics (CHAMMP) program and a number of other studies with budget figures increasing to $82.4 million in FY 1993.

Atmospheric research in OHER also consists of atmospheric chemistry studies, the atmospheric effects of complex terrain, and emergency response research.

In the Department of Interior, Bureau of Reclamation, the weather modification program, has not been funded since FY 1989 except for reimbursable work. Other Department of Interior programs, effects of biological pollutants, acid deposition monitoring, and modeling are stable at about $10.0 million annually. A major portion of this research centers on the visibility studies for Class I areas of National Parks; the 1990 Clean Air Act includes an authorization of $8.0 million into the causes of such visibility reductions. These programs have generally not been reported in this analysis.

In the U.S. Geological Survey, there was a 16 percent decrease in FY 1992 in the Coastal Erosion and Wetland Loss Program, and a slight increase in funding for EEZ and geological framework studies. There is a 5 percent decrease in FY 1993 in offshore geologic framework studies, in EEZ research, and a possible slight decrease in coastal studies.

In DOE, oceanographic efforts support improvement and validation of models of the ocean/atmosphere system and the carbon cycle. This aspect of the program is enhanced in FY 1993. Cycling of carbon on the continental shelf and exchange with the open ocean will continue to be analyzed through basic oceanography. Cooperation with WOCE and GOFS will continue.

Table 1. R&D in the Atmospheric and Ocean Sciences

(Budget Authority in millions of dollars)

	FY 1991 Actual	FY 1992 Estimates	FY 1993 Estimates
Atmospheric			
NASA[1]	-----	---------	---------
NSF	116.6	127.2	151.9
DOD	65.6	67.1	75.7
DOC (NOAA)	128.2	128.5	156.0
DOE	53.5	60.6	82.4
DOA	24.7	24.9	24.2
Oceanic			
NASA	-----	--------	---------
NSF	164.6	178.8	206.4
DOD	105.0	106.0	112.0
DOC (NOAA)	84.5	83.6	80.1
USGS	37.7	36.7	29.6
DOE	10.3	12.6	18.5

[1] It is not possible to divide the FY 1993 NASA budget accurately between the two disciplines.

Table 2. R&D in NASA's Atmospheric and Ocean Sciences

Earth Science and Applications

	FY 1991 Actual	FY 1992 Estimates	FY 1993 Estimates
Earth observing system	150.6	184.4	308.4
EOS data information system	36.0	82.6	82.6
Earth probes (including Scatterometer)	51.7	92.8	88.9
Remotely piloted aircraft	-----	--------	---------
Upper atmosphere research satellite mission	62.0	--------	---------
Ocean topography experiment	80.4	59.9	---------
Payload and instrument development	49.1	39.6	49.4
Mission operations and data analysis	39.4	83.8	142.1
Interdisciplinary research	12.4	2.5	2.6
Modeling and data analysis	44.3	49.0	45.0
Process studies	116.2	123.6	126.6
Research facilities	20.2	20.3	22.9
Total	662.3	738.5	868.5
Physics and Astronomy Program			
Global geospace science	96.6	75.3	60.1
Research and analysis	98.3	70.5	81.4
Suborbital program	55.0	60.2	65.3

Table 3. R&D in NSF's Atmospheric Sciences

	FY 1991 Actual	FY 1992 Estimates	FY 1993 Estimates
Atmospheric Science Project Support	61.3	69.2	79.3
National Center for Atmospheric Research	48.9	51.4	64.7
Upper Atmospheric Research Facilities	6.4	6.6	7.9
Total	116.6	127.2	151.9

Table 4. R&D in NSF's Ocean Sciences

	FY 1991 Actual	FY 1992 Estimates	FY 1993 Estimates
Ocean Sciences Project Support	82.0	90.8	109.2
Oceanographic Centers and Facilities	47.7	51.6	59.3
Ocean Drilling Program	35.0	36.4	32.8
Total	164.6	178.8	206.4

Table 5. R&D in DOD's Atmospheric and Oceanic Sciences

	FY 1991 Actual	FY 1992 Estimates	FY 1993 Estimates
Atmospheric Sciences			
Army	15.7	14.8	16.9
Navy	18.1	19.2	21.3
Air Force	31.8	33.1	37.5
Subtotal	65.6	67.1	75.7
Oceanic Sciences			
Navy	105.0	106.0	112.0

Table 6. The National Oceanic and Atmospheric Administration

	FY 1991 Actual	FY 1992 Estimates	FY 1993 Estimates
National Ocean Service	------	165.1	142.6
National Marine Fisheries	------	225.7	221.5
Oceanic & Atmospheric Research	------	212.9	193.7
National Weather Service	------	443.6	501.0
NESDIS	------	338.4	437.9
Program Support	------	147.6	155.7
Total	------	1,533.3	1,652.5

Chapter 15

Earth Sciences in the FY 1993 Budget

American Geological Institute

Craig M. Schiffries

Introduction

Earth sciences research and development (R&D) programs are dispersed throughout the federal government. This chapter focuses on the President's FY 1993 budget request for earth sciences R&D in the National Science Foundation (NSF), the Department of the Interior, the Department of Energy (DOE), and NASA. It emphasizes the solid earth sciences. Complementary chapters provide detailed information about atmospheric and oceanic sciences, and water resources.

Interagency Presidential initiatives coordinated by the White House Office of Science and Technology Policy (OSTP) play an increasingly important role in the federal R&D budget. Of the five major Presidential R&D initiatives in the FY 1993 budget, the U.S. Global Change Research Program has a particularly significant impact on the earth sciences.

Highlights of earth sciences research and development in the President's FY 1993 budget request include:

- Deep cuts in many earth sciences programs in the Department of the Interior.

- A 15.6 percent increase in the budget request for the Earth Sciences Division of the National Science Foundation (NSF). More than 90 percent of the increment is focused on several areas -- including global change, environmental research, hydrology, and the global seismic network -- and total funding for all other areas may decline after adjusting for inflation.

- The budget request for the interagency Global Change program is 24 percent above the FY 1992 level, but the subtotal for research on solid earth processes is 3 percent below the FY 1992 level.

National Science Foundation

The FY 1993 budget request for the National Science Foundation is $3.03 billion, an increase of $453.5 million, or 17.6 percent, over the FY 1992 current plan. The request for the geosciences component of the NSF budget is $472.4 million, an increase of $68.0 million, or 16.8 percent, over the FY 1992 current plan. According to the NSF budget summary, the increment in the geosciences budget request includes $40.2 million for support of individual investigators.

Earth sciences is one of five subcomponents of the geosciences budget (Table 1). The request for the earth sciences subcomponent is $88.1 million, an increase of $11.9 million, or 15.6 percent over the FY 1992 level (Table 2). The increment in the earth sciences budget is not distributed across all areas of research; 99 percent of the increment is focused on six areas (Table 3), and total research in all other areas may decrease after adjusting for inflation.

An analysis of the increment in the FY 1993 earth sciences budget request provides information about the agency's R&D

priorities (Table 3). Global Change research accounts for 32 percent of the increment in the earth sciences budget, including 37 percent of the increment for project support and 67 percent of the increment for the continental dynamics program. Other environmental research and instrumentation accounts for 22 percent of the increment in the earth sciences budget. A new program emphasis in hydrologic sciences accounts for 21 percent of the increment. Expanding the global seismic network accounts for another 17 percent of the increment. The total increment in these four areas (global change, other environmental research and instrumentation, hydrology, and the global seismic network) accounts for 92 percent of the increment in the earth sciences budget.

Department of Interior

U.S. Geological Survey. The U.S. Geological Survey (USGS) is the primary federal geoscience research organization. The FY 1993 budget request for the USGS is $540.3 million, a decrease of $42.4 million, or 7 percent, under FY 1992 appropriations. The FY 1993 budget also calls for a reduction in staff by 250 full time equivalents.

USGS research activities are conducted in three divisions: Geologic Division, National Mapping Division, and Water Resources Division. The FY 1993 budget request for the Geologic Division is 9.5 percent below FY 1992 appropriations. Among the Geologic Division programs targeted for even deeper cuts are geologic framework and processes (-23 percent), geologic hazards surveys (-15 percent), and global change research (-11 percent). The only program to post an increase greater than 1 percent is energy geologic surveys, which increased by 6 percent.

Other Bureaus. Earth sciences highlights of the FY 1993 budget request for other bureaus of the Department of the Interior include:

- A 42 percent cut in the science and technology budget for the Bureau of Reclamation.

- A 31 percent cut in the research budget for the Bureau of Mines, including a 100 percent reduction in funding for Mineral Institutes.

- A 6 percent decrease in the Mineral Management Service's resource evaluation program for outer continental shelf lands.

Department of Energy

Earth sciences programs are dispersed throughout the Department of Energy. Many earth sciences programs are related to energy supply, but there are large earth sciences components in waste disposal programs.

The largest geoscience research program is in Basic Energy Sciences. The FY 1993 budget request for the BES program is \$813.9 million, an increase of \$49.2 million or 6.4 percent, over the 1992 budget authority. The engineering and geosciences component of that request is \$39.6 million.

Most of the global change research at DOE is carried out under its Biological and Environmental Research program, which is requesting \$113.0 million for its role in the program in FY 1993.

The FY 1993 budget request for the Fossil Energy Research and Developments program is \$311.3 million, a decrease of \$130.0 million or 29.9 percent relative to FY 1992 appropriations. The budget request for petroleum R&D is \$57 million, a decrease of \$0.3 million or 0.5 percent. For natural gas, the budget request is \$40 million, an increase of 27.4 million or 217 percent. The coal R&D budget request is \$118.9 million, a decrease of \$109.1 million or 47.9 percent. Significant parts of the oil and gas subprograms are geoscience oriented, whereas the coal subprogram contains few geoscience components.

In oil and gas, Secretary of Energy Watkins said a refocused advanced recovery program "is one of the most important initiatives in the National Energy Strategy to reduce oil supply vulnerability. The program is aimed at keeping in production many aging U.S. reservoirs that otherwise would be abandoned, while ushering in a new generation of more effective oil recovery technologies." The new effort in natural gas would depart from the agency's historical emphasis -- such as eastern shales and western tight sands -- and focus instead on better drilling, diagnostic and reservoir characterization that could apply to all gas-bearing formations, including conventional gas fields.

Environmental Restoration and Waste Management is the fastest growing program in the Department of Energy. The budget request for FY 1993 is $5.317 billion, an increase of $1.034 or 24 percent over FY 1992 appropriations, and more than three times the amount spent on this activity in FY 1989. DOE has made a major commitment to environmental restoration and waste management related to DOE facilities and disposal sites, and geotechnical considerations are an important part of this effort.

The Nuclear Waste Disposal program has significant earth sciences components. The FY 1993 budget request for site characterization at Yucca Mountain in Nevada is $248.3 million, an increase of $166 million, or 50 percent, over the FY 1992 level.

The Energy Supply Research and Development program includes geothermal energy research budgeted at $22.17 million for FY 1993, a decrease of $2.8 million, or 10.2 percent under the FY 1992 level. Part of the geothermal budget is for geoscience-oriented resource characterization and production research.

NASA

The FY 1993 budget request for NASA is $14.993 billion, an increase of 4.5 percent, or $641 million over FY 1992 appropriations. The total R&D budget is $7.731 billion, an increase of 12.9 percent, or $880.6 million over FY 1992. The Earth Science and Applications component of the R&D budget is $868.5 million, an increase of 16.2 percent, or $121.0 million over FY

1992. The major subcomponents of Earth Science and Applications budget are listed in Table 4.

The Presidential initiative on Global Change plays a major role in NASA's FY 1993 budget submission. The Earth Observing System, which has recently undergone a major restructuring, and the Earth Probes program make up NASA's "Mission to Planet Earth" program and comprise the agency's major contributions to the U.S. Global Change Research Program. The earth probes funded in the FY 1993 budget include a total ozone mapping spectrometer and a tropical rainfall mapping mission. Another important item in the FY 1993 budget related to the global change program is the inclusion of $25 million in funding for the first phase of a cooperative NASA/DOD LANDSAT 7 program.

Other Agencies

Earth sciences R&D is conducted by other federal agencies, including the Environmental Protection Agency, the Department of Defense, and the Department of Agriculture. It is relatively difficult, however, to track and evaluate the earth sciences R&D components of their budgets.

A significant amount of geophysical R&D conducted by the Department of Defense is classified. The end of the Cold War may accelerate efforts to declassify important geophysical data, including certain seismic, topographic, and satellite data.

Interagency Programs and Initiatives

Global Change Initiative. The FY 1993 budget request for the U.S. Global Change Research Program is $1.372 billion, an increase of $263 million, or 24 percent, over FY 1992. Eleven agencies have a major involvement in global change research activities (Table 5), and only the Department of Interior has a smaller budget in FY 1993 than FY 1992.

Table 6 shows a breakdown of the Global Change budget by scientific discipline. Despite a large increase in the overall budget for the Global Change program in FY 1993, the budget for the Solid Earth Processes subprogram is 3 percent lower than the FY 1992 level (Table 6). A $4.2 million decrease in the NASA's budget for the Earth Probes program accounts for the largest share of the decrease in the Solid Earth Processes budget of the Global Change program.

The FY 1993 budget request for the Global Change subprogram in Earth System History is $23.4 million, an increase of $4.1 million or 21.2 percent over FY 1992. That increase is dominated by a $4.0 million increase in the NSF budget for the Earth System History subprogram.

Earthquake Hazard Reduction Program. The National Earthquake Hazard Reduction Program (NEHRP) is the principle source of federal funding for earthquake hazard mitigation. It supports major research programs conducted by the USGS, NSF, and FEMA.

Congress passed NEHRP in response to concerns raised by the 1971 San Fernando earthquake. Funding for NEHRP declined in real dollars until California was hit by another large earthquake in 1989. Funding for NEHRP may begin to decline once again. The FY 1993 budget request indicates that NSF support for NEHRP will be maintained at the FY 1992 level, and USGS support for earthquake hazard reduction will decline by 13 percent.

Table 1. National Science Foundation: Geosciences Budget
(Millions of Dollars)

Program Element	FY 1991 Actual	FY 1992 Plan	FY 1993 Request	Change 92-93 Amount	Change 92-93 Percent
Atmospheric Sciences	$116.6	$127.2	$151.9	$24.7	19.4
Earth Sciences	70.8	76.2	88.1	11.9	15.6
Ocean Sciences	164.6	178.8	206.4	27.6	15.4
Arctic Research Program	14.9	21.3	26.0	4.7	22.1
Science & Tech. Centers[1]	0.8	0.9	0.0	-0.9	-100.0
Total Geosciences	$367.7	$404.4	$472.4	$68.0	16.8
Total NSF	$2,413.1	$2,573.5	$3,027.0	$453.5	17.6

Source: NSF budget summary. All data in nominal dollars.

[1] Funding for existing science and technology centers is included in discipline subactivities.

Table 2. NSF Earth Sciences Division of Geosciences Directorate
(Millions of Dollars)

Program Element	FY 1992 Plan	FY 1993 Request	Change Amount	Change Percent
Earth Sciences Project Support	$49.65	$57.31	$7.66	15.4
Continental Dynamics	6.71	8.21	1.50	22.4
Instrumentation and Facilitie	19.86	22.62	2.76	13.9
Total Earth Sciences	$76.22	$88.14	$11.92	15.6

Source: NSF budget summary. All data in nominal dollars.

Table 3. Increases in the FY 1993 NSF Earth Sciences Budget Request
(Millions of Dollars)

Program	Project Support	Cont. Dynam.	Instr. & Fac.	Subtotal Amount	Subtotal Percent
Global change research	$2.80	$1.00	$0.00	$3.80	32
Environmental research	1.66	0.50	0.50	2.66	22
New program in hydrology	2.50	0.00	0.00	2.50	21
Global seismic network	0.00	0.00	2.00	2.00	17
Postdocs & undergrad ed.	0.70	0.00	0.00	0.70	6
High performance computing	0.00	0.00	0.1	0.13	1
All other areas	0.00	0.00	0.13	0.13	1
Total increase	$7.66	$1.50	$2.76	$11.92	100

Increases in FY 1993 budget request relative to FY 1992 current plan, in nominal dollars. Source: NSF. Abbreviations: Cont. Dynam. = Continental Dynamics; Instr. & Fac. = Instrumentation and facilities.

Table 4. NASA: Earth Science & Applications Budget
(Millions of Dollars)

Program	FY 1992	FY 1993	Change Amount	Change Percent
Earth Observing System	$188.4	$308.4	$120.0	63.7
EOS Data Information System	82.6	82.6	0.0	0.0
Earth Probes	92.8	88.9	-3.	-4.2
Ocean Topography Experiment	59.9	0.0	-59.0	-100.0
Payload & Instrument Development	39.6	49.4	9.8	24.8
Mission Operations & Data Analysis	88.8	142.1	53.3	60.0
Research & Analysis	175.1	174.2	-0.9	-0.5
Airborne Science and Applications	20.3	22.9	2.6	12.8
Total Earth Science & Applications	$747.5	$868.5	$121.0	16.2
Total NASA R&D	$6,850.8	$7,731.4	$880.6	12.9

Source: NASA. All data in nominal dollars.

Table 5. Global Change Research Program
Focused Budget by Agency (Millions of Dollars)

Agency	FY 1992	FY 1993	Change Amount	Change Percent
NASA	$755.9	$890.8	$134.9	17.8
NSF	108.5	162.5	54.0	49.8
Department of Energy	77.0	113.0	36.0	46.8
NOAA	47.0	78.2	31.2	66.4
Dept. of Agriculture	44.3	47.6	3.3	7.5
Department of Interior	39.4	35.8	-3.6	-9.1
EPA	24.0	26.0	2.0	8.3
Smithsonian	6.3	10.6	4.3	68.3
Department of Defense	6.3	6.6	0.3	4.8
HHS	1.0	1.2	0.2	20.0
Tennessee Valley Auth.	0.1	0.1	0.0	0.0
Total	$1,109.8	$1,372.4	$262.6	23.7

Source: OSTP. All data in nominal dollars.

Table 6. Global Change Research Program
Budget by Science Element (Millions of Dollars)

Science Element	FY 1992	FY 1993	Change Amount	Change Percent
Climate & Hydrologic Systems	$505.5	$629.2	$123.7	24.5
Biogeochemical Dynamics	288.0	333.2	45.2	15.7
Ecological Systems & Dynamics	152.8	240.4	87.6	57.3
Solid Earth Processes	108.6	105.2	-3.4	-3.1
Human Interactions	16.8	25.9	9.1	54.2
Earth System History	19.3	23.4	4.1	21.2
Solar Influences	18.8	15.1	-3.7	-19.7
Total	$1,109.8	$1,372.4	$262.6	23.7

Source: OSTP. All data in nominal dollars.

Chapter 16

Water Resources Research in the FY 1993 Budget

Universities Council on Water Resources

Robert C. Stiefel

INTRODUCTION

Water-related research is included in some way in most of the cabinet level departments and independent agencies in the Federal government, but this effort at examining the budget for water resources research is limited to the four departments and agencies having a major responsibility for the resource. In the author's opinion these agencies account for over ninety-five percent of the Federal expenditures for water resources research. Water research in the marine environment and in the atmosphere is not considered, but is included in the Disciplinary Analysis on Atmospheric and Oceanic Sciences.

Funding for water resources research in the Federal FY 1993 budget that is considered in this analysis amounts to $591.3 million. This is an increase of less than one percent of the amount budgeted in FY 1992. Most of the increase can be attributed to the government-wide water quality program.

DEPARTMENT OF THE INTERIOR

The 1993 budget continues a Presidential initiative to establish the scientific basis for national and international policy-making relating to global change with the establishment of the U. S. Global Change Research Program (USGCRP).

The Department of Interior is requesting $35.8 million in 1993 for its component of the USGCRP, a decrease of $3.6 million, or 9 percent, over the 1992 enacted level of $39.4 million.

The Department of Interior, through the Geological Survey (GS), in consultation with other Federal and state agencies, will continue its implementation of the National Water Quality Assessment (NAWQA) program in 1993. The objective of the program is to describe the status and trends in the quality of a large, representative part of the Nation's surface water and ground water resources and to provide a sound, scientific understanding of the primary natural and human factors affecting these conditions.

Geological Survey

The 1993 request for Water Resources Research and Investigations is $169.8 million. The request includes $41.9 million, an increase of $13.5 million over FY 1992, for the National Water Quality Assessment (NAWQA) program. Regional and national synthesis of key findings from study units are the foundation for comprehensive assessments of the Nation's water quality. The NAWQA Program represents a key element of the President's Water Quality Initiative. The first national synthesis to be undertaken in FY 1993 is related to the occurrence and distribution of pesticides from agricultural contamination in ground water and surface water. The aggregation and analysis of findings on nutrient and sediment concerns will also begin in FY 1993.

Funding for the Water Resources Research Institutes and Grant Programs are proposed at greatly reduced levels. These reductions will result in a decrease in funding to each of the 55 Water Resources Research Institutes of approximately 51 percent from the FY 1992 enacted levels of $105,000 per Institute to a level of $52,000 per Institute. In addition, the number of research projects funded through the National Water Resources Research Grants program have been reduced from 36 in 1991 to 15 in 1992 to none in 1993.

The Bureau of Reclamation

The request for General Investigations is $12.7 million. General investigations funds are used to study water related problems in the West and to identify and evaluate a broad range of alternative solutions. Most of the studies emphasize nonstructural, management, and conservation solutions to current water resources problems. The studies also emphasize the protection of water quality and fish and wildlife and the preservation restoration of wetlands.

Fish and Wildlife Service

The Fish and Wildlife Service conducts fish and wildlife research at the Service's 13 laboratories and operates Cooperative Research Units at 38 universities in 36 states. In support of Historically Black Colleges and Universities, the Service has established a Cooperative Research Unit at the University of Maryland - Eastern Shore. The Service conducts research and training to improve wildlife management capabilities, improve sport fish productivity, protect species that are endangered or threatened, assist in the implementation of recovery programs, and prevent or minimize adverse environmental effects on fish and wildlife resources.

DEPARTMENT OF THE INTERIOR

(in millions)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Budget
U. S. Geological Survey			
National Water Resources Research & Information System-			
Federal Program	$ 100.9	$ 111.3	$ 106.0
Federal/State Coop Prog.	65.8	63.3	60.5
State Research Institutes	10.7	8.0	3.3
Total	$ 177.4	$ 182.6	$ 169.8
Bureau of Reclamation			
General Investigations	$ 6.9	13.2	12.6
Total	$ 6.9	$ 13.2	$ 12.6
Fish & Wildlife Service			
Research and Development-			
Coop Research Units	$ 7.6	$ 7.6	$ 8.1
Fisheries Research	11.4	19.4	17.2
Total	$ 19.0	$ 27.0	$ 25.3

ENVIRONMENTAL PROTECTION AGENCY

The 1993 President's budget provides a total of $528.4 million for EPA's research and development program. This represents an increase of $26.4 million over the 1992 level.

The major increases will enhance ecological systems research, help implement the Clean Air Act legislation, support new media research needs and strengthen the Agency's long-term research capabilities.

Funds for Water Quality Research will be increased by $2.1 million to identify, measure and compare wetlands functions and values; to focus on the impact of multimedia nitrogen on estuarine and near coastal ecosystems, particularly the Chesapeake Bay; to continue support for the Great Lakes initiative that includes monitoring fresh water sediments, assessing the impact of the zebra mussel and studying the sources of toxic chemicals; and to improve the ecological value of the Gulf of Mexico.

Drinking Water Research will continue to develop methods to prevent contamination of ground water sources. Additional funds will be provided for detecting and removing contaminants from public drinking water and disinfection systems. The Agency will also target chemicals used to disinfect water as well as chemicals that are created as a result of the disinfection process.

Funds for Hazardous Waste Research will decrease by $7.9 million. EPA will continue research on bioremediation and municipal solid waste (MSW), and provide increased site-specific technical information for RCRA corrective actions. Research will continue to evaluate pollution prevention techniques and innovative technologies for municipal waste disposal.

Funds for Multimedia Research will increase $17.1 million to strengthen the Agency's long-term research program; to upgrade scientific research equipment; and to enhance risk based media research.

ENVIRONMENTAL PROTECTION AGENCY

(in millions)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Budget
Office of Research and Development			
Water Quality	$ 28.0	$ 30.6	$ 32.7
Drinking Water	18.9	22.1	21.9
Hazardous Waste	39.9	47.7	39.8
Multi-Media	120.9	152.7	170.8
Total	$ 207.7	$ 253.1	$ 265.2

DEPARTMENT OF AGRICULTURE

Funds are proposed to continue water quality programs funded in 1992 as part of a coordinated governmentwide initiative. Much of the initiative is being targeted to nonpoint source pollution identified in plans developed by States under requirements of Secion 319 of the Water Quality Act of 1987. Agriculture has been identified as a nonpoint source pollution contributor in many States. The major objective of the USDA water quality initiative is to provide farmers, ranchers and other land managers with the information necessary to voluntarily adopt improved, environmentally-sound management practices which do not sacrifice profitability.

The initiative will be evaluated based on water quality impacts expected on production factors, management practices and costs of achieving water quality improvements.

The Water Quality Programs are funded at approximately $200 million, an increase of more than 100 percent from 1989, and about the same level as 1992.

Research programs will focus on completion of work in the Midwest and research on specific issues in other areas. Data collection and analysis is continued at the 1992 level. This inclused funding for the pesticide use survey, a multi-year program with the objective of generating improved estimates of pesticide use patterns and trends for all major agricultural crops.

Extension and Soil Conservation Service assistance related to the nationally selected demonstration and hydrologic unit projects will be continued. The increase for ES reflects a funding estimate required to fully support these ongoing projects and to enhance staff training in water quality.

Proposals for financial assistance reflect an increase for water quality incentives projects, but other Agricultural Conservation Programs - based water quality programs would be discontinued. Emphasis will now be placed on analyzing the results of the demonstration projects and hydrological units to determine larger scale applicability.

USDA is proposing a $3.3 million increase in funding for global change research programs in 1993. Research funding is proposed for Federal scientists of ARS, ERS and the Forest Service and for competitive grants to universities to assure that a broad spectrum of expertise can be engaged in developing appropriate solutions to major issues identified in global change plans. Priorities for 1993 research include work to better understand the carbon cycle, development of basic hydrologic models to understand the effects of global change on water availability at local, watershed and regional levels and research to improve energy systems from biomass fuels.

Agricultural Research Service conducts basic and applied research at Federal laboratories to solve problems encountered by agricultural producers and consumers of farm and ranch products. ARS will continue a major program of water quality research in the Midwest and other production areas in cooperation with university researchers.

The mission of the Soil Conservation Service is to improve and conserve soil and water resource quantity and quality, improve agriculture, and reduce damage caused by floods and sedimentation. At the 1993 budget level of $791.4 million, SCS will continue to place top priority on continuing its ongoing implementation of the conservation provisions of the FSA of 1985 as well as meeting the new requirements of the FACT Act. This level of funding will also allow continued support for the Administration goals for enhancing water quality and preserving wetlands.

Federally-funded agricultural research conducted in partnership with the State Agricultural Experiment Stations (SAES) is administered through the Cooperative State Research Service. CSRS will provide $9.0 million for university research as part of USDA water quality program consistent with the USDA Research Plan for Water Quality.

DEPARTMENT OF AGRICULTURE
(in millions)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Budget
Water Quality Program			
Agricultural Research	$ 42.5	$ 45.7	$ 46.2
Coop State Research	32.9	32.9	32.6
Economic Research	1.8	1.8	1.8
Soil Conservation	0.1	0.0	0.0
Total	$ 77.3	$ 80.4	$ 80.6

National Science Foundation

Water resources related research funded by the National Science Foundation is included in several subactivities within the Engineering and Geosciences Activities. The Biological and Critical Systems and the Chemical and Thermal Systems Programs in Engineering Activity and the Global Geoscience Program in the Geoscience Activity which is the focus of NSF's contribution to the U. S. Global Changes Research Program, are the areas primarily doing water resources related research.

NATIONAL SCIENCE FOUNDATION
(in millions)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Budget
Engineering Activity			
Biological/Critical Sys.	$ 5.9	$ 6.8	$ 7.4
Chemical and Thermal Sys.	9.3	9.9	10.2
Geoscience Activity			
Global Geoscience Program	12.5	16.7	20.2
Total	$ 27.7	$ 34.4	$ 37.8

Chapter 17

FY 1993 R&D in the Biological Sciences

American Institute of Biological Sciences

Jennie Moehlmann

Highlights

- NSF Biology Directorate. The newly revised Directorate for Biological Sciences at the National Science Foundation would see a proposed 17 percent increase in its funding level if the President's proposed budget is enacted. This increase is consistent with the Administration's goal of doubling the NSF budget by 1994.

- USDA National Research Initiative. In its third year, the National Research Initiative at the U.S. Department of Agriculture received a proposed $150 million for competitive research grants. This is over a 50 percent increase from the current NRI funding level.

- Biotechnology Research Program. Included in the FY 1993 budget is a cross-cut detailing the biotechnology research conducted at all the federal agencies. Under the budget proposal, total spending for biotechnology research will increase 7 percent to total just over $4 billion. Twelve federal agencies are involved in the biotechnology initiative. Basic biotechnology research and health research total nearly 79 percent of the federal spending. The other areas of research are agriculture (5 percent), energy (3 percent), environment (2 percent), manufacturing/bioprocessing (3 percent), and infrastructure research (8 percent).

Department of Interior

Research funding at the Fish and Wildlife Service (FWS) is again slated for a decrease by the Bush Administration. Total research spending at FWS is currently appropriated at $85.3 million. Under the president's proposal, research funds would decrease to $81.9 million. Two-thirds of FWS research is conducted under four broad categories: wildlife research ($17.1 million, down from $18.1 million), fisheries research ($17.3 million, down from $19.4 million), endangered species research ($7.1 million, down from $7.8 million), and contaminants research ($13.3 million, down from $13.6 million).

Interior's part in the biotechnology initiative is relatively minor, with only $5.1 million allocated. Research includes activities at the U.S. Geological Survey which focus on microbial processing of hazardous substances in surface and subsurface waters. Over 20 research grants in the areas of biotransformation, biodegradation, biomonitoring, and bioremediation of contaminants and wastes will be funded through Interior.

The Department also plays a role in the Administration's global climate change initiative. Interior has requested $35.8 million to conduct research on the causes and effects of global change in the terrestrial environment. Studies will emphasize how and why changes occurred in the past, the current state of the environment, and what processes are likely to affect the environment in the future.

Research on environmental technology at Interior's Bureau of Mines (BOM) is scheduled for a $5 million decrease from $18 to $13 million under the Bush budget. BOM conducts research on bioprocessing of minerals, bioremediation, and mining reclamation.

National Aeronautics and Space Administration

Following two recent successful space shuttle missions that focused primarily on life sciences research, the proposed budget for the Life Sciences Division of NASA's Office of Space Sciences and Applications (OSSA) will grow by nearly 19 percent to $175.6

million. The research agenda includes studies on the effects of long-term exposure to weightlessness and the development of biological flight experiments for use on future space shuttle missions and on Space Station Freedom. The space station, with dual objectives as a life sciences laboratory and materials research facility, received a 10 percent increase in the Bush budget request, to total $2.25 billion.

NASA provides unique opportunities for life science studies, with an emphasis on the role that gravity plays in the determination of the structure and function of biological systems. Within OSSA is a program to develop a closed ecological life support system which will ultimately enable long-duration human space flight. OSSA also sponsors the Space Biology Program that studies basic science questions related to the effects of microgravity on cell and developmental biology for both plants and animals. NASA's role in the biotechnology initiative is to continue research on protein crystal growth, separation technologies for biological materials, and cell culture studies.

NASA support for the global climate change initiative increases 18 percent to nearly $891 million. NASA, with nearly 65 percent of the total funding for the global change initiative, primarily focuses its research on space-based observation systems.

Department of Energy

Reversing a recent trend, the Bush Administration has proposed an increase in DOE's Biological and Environmental Research (BER) program. BER, a division of the Office of Energy Research, is slated for an increase from the current funding level of $353.3 million to $384.7 million. Included in the BER program are several projects aimed at determining the environmental consequences of energy use and development. These areas of research include environmental research ($46.3 million), health effects research ($41.1 million), general life sciences research ($104.6 million), and nuclear medicine studies ($39.3 million). Planned 1993 activities include programs in global climate change; terrestrial and oceanographic processes; molecular, cellular, and systemic studies on the biological effects of radiation;

structural biology; and medical applications of nuclear technology. Funding for DOE's part in the Human Genome Program (included in the general life sciences program) is proposed to increase to $65 million. This is a joint project with the National Institutes of Health.

DOE has the largest nonmedical biotechnology program supported by the federal government. Its proposed budget is $173 million. The major biotechnology research programs include genome projects, structural biology, biological processing of fossil fuels, environmental mitigation, and bioprocess engineering.

One of BER's major programs is the global climate change initiative, for which $113 million is requested. BER research focuses on quantifying the role of clouds and oceans in climate change and on studying the sources and sinks in the global carbon cycle. BER is also conducting research to quantify the link between the rise of greenhouse gases and global warming, and to determine the impact on human and natural resources.

National Oceanic and Atmospheric Administration

National Ocean Service. The NOS program, which monitors and assesses the health of coastal and marine resources and environments, is scheduled for a substantial decrease in the President's budget proposal. Current funding for NOS is nearly $170 million, but under the Bush budget, NOS would receive only $142.6 million. Within NOS, funding for the Observation and Assessment program would drop from $61.8 million to $52.8 million. The decrease, according to the budget statement, is "associated with activities that can be provided by the private sector, financed by individual states involved, or funded from monies obtained through legal settlements." An increase of $5.5 million, however, is proposed to continue the study of environmental degradation in coastal ocean areas.

National Marine Fisheries Service. Under the Bush proposal, NMFS' Information Collection and Analyses program will decrease by nearly $15 million to total $114.5 million. However, marine mammal research funding will increase by nearly

$0.6 million to $3 million. A new proposal to establish a marine mammal tissue bank is included in NMFS' Conservation and Management Operations sub-activity which saw an increase of over $10 million to $83.2 million.

Oceanic and Atmospheric Research. Three of the Ocean and Great Lakes Programs (Marine Prediction Research, Sea Grants, and the National Undersea Research Program) will lose nearly $50 million of their current allocation of $88.3 million under the Bush plan. These programs, according to the budget, primarily support State, regional, or private sector interests. The OARS' Climate and Air Quality Research activity received a $33 million increase targeted primarily for the global climate change initiative. NOAA's portion of that project is up $31 million to $78.2 million.

The three major NOAA programs connected with biotechnology research, NMFS, the National Undersea Research Program, and Sea Grants, all received substantial decreases in the budget plan. In fact, the undersea research program has once again been proposed for elimination. Total funding for all Department of Commerce agencies (including the National Institute of Standards and Technology and the International Trade Administration) for the biotechnology initiative is $13 million, the same as in 1992.

Environmental Protection Agency

EPA's R&D program for 1993 received a 6 percent increase under the proposed budget to $338.5 million. Areas of media-related research include Air ($93.7 million), Water Quality ($16.7 million), Pesticides ($8.4 million), and Multimedia ($155.27 million). Priorities identified in the budget include research programs on indoor air, global change, and stratospheric ozone depletion. In addition, the Coastal Zone Act Reauthorization Amendments created important new responsibilities in the EPA for identifying nonpoint source pollutants.

EPA will have a primary role in developing new approaches and techniques for pollution remediation under its part of the biotechnology initiative. Total EPA spending under the initiative will increase 15 percent to $18.3 million.

National Institutes of Health

Although NIH received a nominal increase of $443 million for research, this figure actually represents a freeze from the 1992 level when adjusted for biomedical inflation. The increase brings the total NIH research budget to $9.4 billion. Approximately 85 percent of this increase is already allocated to previously awarded Research Project Grants. Within the total budget, $5.3 billion is requested to fund 22,132 grants. The number of new grants, however, will decline by more than 200 to 5797. The request targets increases for health research on women and minorities. AIDS basic science research will also keep pace with inflation, increasing from $889 million to $932 million.

The remainder of the NIH research program will continue at the same level as 1992, which is actually a decrease when inflation is taken into consideration. These programs include research centers ($788 million), research and development contracts ($644 million), the research training program ($309 million), and other research grants ($397 million). NIH research management and support ($432 million) and the intramural research program ($1.042 billion) will receive increases to account for inflation.

NIH receives the bulk of funding in the biotechnology initiative, $2.944 billion, nearly 75 percent of the total federal biotech spending. Current research programs at NIH involve technology development for DNA manipulation, development of novel computing approaches, study of transgenic animal models, and, most recently, gene therapy. Other agencies within the Department of Health and Human Services with ongoing research in biotechnology include the Food and Drug Administration ($36.2 million), the Centers for Disease Control ($33.7 million), and the Alcohol, Drug Abuse, and Mental Health Administration ($111.2 million).

National Science Foundation

Funding for the redesigned Biological Sciences Directorate (BIO) at NSF is up 16.9 percent to $320.6 million. This figure is just short of the 17.9 percent increase for the entire NSF research budget. Reorganization at NSF earlier this year created a new directorate for the behavioral and social sciences, which had previously been incorporated with the biological sciences under a single directorate (the former BBS). BIO research comprises 14.5 percent of the total research budget at NSF and supports research in cellular and molecular biology, neural sciences, environmental biology, and adds a major new cluster, organismal research called integrative biology. Ninety percent of the BIO budget will support individual investigator research.

NSF's role in the biotechnology initiative focuses on five areas: environmental biotechnology, bioprocessing, bioelectronics and bionetworks, agricultural biotechnology, and marine biotechnology. Total funding for the biotechnology initiative at NSF is proposed at $205.6 million, which includes $15.2 million to enhance interdisciplinary research in biotechnology. The BIO Directorate will take the lead in coordinating this project; the remaining six NSF directorates are also involved.

NSF is also a major participant in the President's global climate change initiative, with a request totaling $162.5 million. NSF focuses on the basic research aimed at understanding and predicting future changes in the earth's environment and the human dimensions associated with these changes. Under the BIO Directorate, $5.0 million is provided to expand studies on the ecological effects of global environment change, especially climate, as part of the initiative.

NSF support for multidisciplinary research on the environment could total $118 million for FY 1993. NSF support will focus on integrated basic research to provide fundamental understanding of biosphere processes across major areas of science. In the BIO Directorate, $8.8 million is earmarked for multidisciplinary research in environmental biology, including the establishment of a national center for ecological analysis.

BIO support for other presidential initiatives and specific research areas includes:

- $3.0 million for the High Performance Computing and Communication initiative to support multidisciplinary teams which are to assess emerging technologies to solve problems in specific biological research areas.
- $3.3 million for research leading to new biomolecular materials as part of the Advanced Materials and Processing Program.
- $6.8 million to expand support for Research at Undergraduate Institutions, Research Experiences for Undergraduates, and supplements for NSF traineeships.
- $4.3 million for the plant sciences including the enhancement of the *Arabidopsis* genome project and the interagency (NSF and CSRS) plant science initiative.

NSF Biological Sciences Directorate (dollars in millions)

	FY 1991 (actual)	FY 1992 (estimate)	FY 1993 (request)
Molecular and Cellular Biosciences			
Biochemistry and Molecular Structure and Function	$31.3	$33.5	$38.0
Cell Biology	17.7	19.0	22.1
Genetics and Nucleic Acids	27.7	30.4	35.5
Integrative (Organismal) Biology and Neuroscience			
Physiology and Behavior	27.9	30.4	35.3
Neuroscience	29.1	30.6	33.7
Developmental Biology	15.4	16.2	19.5
Environmental Biology			
Systematic and Population Biology	20.1	21.2	25.7
Ecological Studies	25.3	26.0	30.5
Long-Term Projects in Environmental Biology	23.0	25.4	30.4
Instrumentation	37.7	41.7	50.2
Total, BIO Directorate	255.1	274.3	320.6

Department of Agriculture

Agricultural Research Service. Spending for research programs at ARS will increase just 4 percent to $668.4 million under the Bush budget proposal. Areas of emphasis include soil and water conservation ($82.9 million), plant science ($252 million), animal science ($114 million), commodity conversion ($138.2 million), integration of systems ($26.2 million), and human nutrition ($55.1 million). A $3 million increase is proposed for development of biological pest controls and integrated pest management systems to address environmental concerns associated with pest control. An increase of $1.2 million is also proposed to improve the viability of current germplasm collections. Research at ARS also focuses on efforts to improve soil and water management, irrigation, and conservation practices; to protect natural resources from harmful effects of soil, air, and water pollutants and to minimize certain agricultural pollution problems; and to determine the relationship of water and soil types to plant, animal, and human nutrition.

Cooperative State Research Service. The National Research Initiative (NRI), first proposed two years ago, received strong support in the budget proposal, up over $52 million to $150 million. This competitive grant program includes six major areas: natural resources and the environment ($28 million), plant systems ($52 million), animal systems ($32 million), nutrition, food quality, and health ($17 million), processes and new products ($16 million) and markets, trade, and policy ($5 million). This initiative includes funding for an interagency plant genome mapping program for which ARS will serve as the lead agency. Global change research is also conducted through NRI.

Special research grants, also administered by CSRS, declined substantially from $74.5 million to $28.9 million under the proposed budget. Aquaculture research centers and alternative crops research, funded last year at $4 million and $1.2 million, respectively, were again proposed for elimination in the budget.

Forest Service. Research spending at the Forest Service will decline by over $10 million to $173.7 million. Slight increases are slated for Forest Service research related to wetlands, forest health monitoring, and tropical forestry. According to the budget, forest research in 1993 will focus on basic research, thus allowing the private sector to concentrate on developmental and applied research.

Biotechnology research allocations at USDA agencies totals $167.7 million. Studies include genome mapping, pest management, and animal health. USDA is also engaged in an initiative on agriculture-based fuels. Biofuels research, an outgrowth of the 1990 Clean Air Act Amendments, is conducted mainly by ARS ($7.7 million) and CSRS ($5.7 million). This is nearly three times the level of support in 1992.

U.S. Department of Agriculture (dollars in millions)

	FY 1991 (actual)	FY 1992 (estimated)	FY 1993 (proposed)
Agricultural Research Service			
Soil and Water Conservation	$73.0	$82.0	$82.9
Plant Science	232.7	244.8	252.0
Animal Science	107.8	112.5	114.0
Commodity Conversion	121.0	127.4	138.2
Human Nutrition	48.3	49.9	55.1
Integration of Systems	23.5	26.0	26.2
Total, ARS Research	606.3	642.6	668.4
Cooperative State Research Service			
National Research Initiative	73.0	97.5	150.0
Hatch Act Formula	162.3	168.8	168.8
1890 Colleges	26.3	27.4	28.4
Cooperative Forestry Formula	17.9	18.5	15.8
Special Research Grants	62.6	74.5	28.9
Aquaculture Research Centers	3.7	4.0	0.0
Alternative Crops Research	1.2	1.2	0.0
Buildings and Facilities	62.9	75.3	0.0
Other CSRS programs	44.4	41.7	24.1
Total, CSRS	454.3	508.9	416.0

Chapter 18

Chemistry in the FY 1993 Budget

American Chemical Society

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Overview

Increases in the proposed FY 1993 agency budgets are clearly tied to the Presidential Initiatives developed through the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) process, as well as to specific agency thrusts related to their missions. Where chemical researchers follow these priorities, research funding for chemistry would improve. However, NSF-collected data on federal funding to universities indicate that funding for chemistry (defined as a physical science) continues to slow down compared to research funding to all disciplines.

- Support for chemical research at the National Science Foundation (NSF) would increase 15 percent. The bulk of the increase supports presidential initiatives, as well as new Foundation emphases.

- Funding for chemists by the National Institutes of Health (NIH) might be increased through growth in various institutes that have traditionally supported chemistry. However, chemists who work in priority areas, such as biotechnology, are most likely to take advantage of any such increases.

- Chemistry funded through the Department of Defense (DOD) is expected to grow less than inflation.

- Department of Energy (DOE) programs funding chemistry are expected to increase 15 percent over FY 1992. Research growth would be tied to the National Energy Strategy and to the government-wide initiatives.

National Science Foundation

NSF's FY 1993 request contains a total of $2.4 billion for the conduct of R&D, which represents an estimated increase of 21 percent, or $408.0 million, over current levels. Within that request, programs supporting chemistry at the National Science Foundation would rise 15 percent overall, while programs in the Chemistry Division increase 12 percent over FY 1992, to $126.0 million. The Division's request emphasizes support for government-wide initiatives, as well as Foundation-specific initiatives.

- For the presidential initiative in Advanced Materials and Processing, the Chemistry Division is slated to receive an increase of $5 million, with $3.1 million of that supporting new collaborative and individual awards, to be funded out of Special Projects. The Division's participation in the FCCSET Biotechnology Research Initiative would increase 25 percent to $3.3 million to emphasize environmental biotechnology, bioprocessing and bioelectronics, and marine natural products chemistry.

- The new Foundation thrust in environmental research would receive $2.9 million, to be distributed across the Division's programs. Areas of focus include new catalytic processes to reduce waste production, modeling of environmental kinetics, light-induced reactions of chemicals in the biosphere, separation and detection methods, and environmentally benign chemical synthesis.

- Within Physical Chemistry, a $0.7 million increase is targeted to support the presidential initiative in High Performance Computing and Communications. Projects under this program would support the development of parallel computing resources for complex multi-dimensional chemistry modeling problems.

Programs supported through the Materials Research Division are slated to rise 17 percent to $167.5 million in FY 1993. The Division spearheads the Foundation's involvement in the Advanced Materials and Processing Program, with an increase of $18.9 million. In support of this initiative,

- One additional Materials Research Laboratory and one new Materials Research Group would be established in FY 1993.

- Funds for National Facilities and Instrumentation are slated to rise $1.5 million.

Support for individual investigators would increase 24 percent, or $19.0 million, through the Materials Research Project Support activity, primarily to support Advanced Materials and Biotechnology Research, as well as a new Foundation thrust in advanced manufacturing.

Within Geosciences, Global Change activities would increase $44.0 million, for a total of $133.7 million, with continued emphasis on modeling ocean circulation and ocean-atmosphere coupling, atmospheric chemistry and biogeochemical cycles, hydrologic system studies, and examination of Arctic systems. Within this total, Atmospheric Sciences Project Support is slated to grow $8.3 million in support of the Global Tropospheric Chemistry program, as well as other studies of global energetics and dynamics.

National Institutes of Health

Funding for the conduct of R&D at the National Institutes of Health is slated to increase 5.5 percent over the FY 1992 level to $8.9 billion, only slight growth over projected biomedical inflation of 5.1 percent. Within the increase, research project grants are targeted for 7 percent growth to $5.3 billion, bringing the number of these awards to an all-time high of 22,132. However, the funding increase is intended to cover commitments from previous years, and the number of competing new grants actually is expected to decline from 6,001 to 5,800 awards. In order to keep the number of new grants from declining further, the average size of competing grants (NIH-wide) would only grow 1 percent, which is a significant loss in the buying power of each new grant.

The NIH Director's Discretionary Fund, part of which supports the Shannon Award Program, would grow 12 percent to $20.0 million. Most other mechanisms of research support at NIH—training, centers, R&D contracts, and construction—would be frozen at, or near, their nominal FY 1992 levels. By comparison, the intramural program would grow approximately 5 percent.

Since no program within the NIH solely supports chemical research, opportunities for chemists must be gauged by following trends within institutes that have traditionally supported chemically related studies or scientists in academic chemistry departments. While increases in various institutes might indicate increased opportunity for chemists, recent history indicates that this would not entirely translate into increased funding. Large priority-setting efforts, such as the presidential initiative in Biotechnology Research, would receive considerable amounts of any funding increases, and chemists working in these areas would fare better when seeking grants.

By far the greatest support comes from the National Institute of General Medical Sciences (NIGMS), which funded about $100 million in chemical research during FY 1991. Overall, NIGMS has been slated for a 6 percent increase to $862.1 million, and research support would increase 6 percent to $770.0 million. Like NIH as a whole, research training at NIGMS remains frozen at the nominal FY 1992 level, providing $92.1 million to these programs.

Within NIGMS, the Biophysics and Physiological Sciences Program is slated to rise 8 percent to $177.1 million. This program supports considerable analytical chemistry research, as well as research on biophysical chemistry of large molecules. The Cellular and Molecular Basis of Diseases Program, which contains numerous opportunities for chemists to study the molecular-level biochemistry of cellular processes, would receive a 6 percent increase to $237.9 million. The Pharmacological Sciences Program is scheduled to increase 6 percent to $129.9 million. Basic chemical studies of all kinds, with particular attention to organic and inorganic synthesis, are funded by this last program.

The second largest supporter of chemistry at NIH, the National Cancer Institute (NCI), funds about one quarter the amount of chemistry that NIGMS does. NCI support for research is slated to increase only 3 percent to $2.0 billion. Other institutes providing considerable support for chemistry (about $10 million a year each) increase their commitment to the conduct of R&D in FY 1993: the National Heart, Lung, and Blood Institute, up 5 percent to $1.2 billion; the National Institute of Diabetes and Digestive and Kidney Diseases, rising 6 percent to $674.4 million; and the National Institute of Allergy and Infectious Diseases, up 5 percent to $990.7 million.

The 5 percent increase to $327.6 million in funding for the conduct of R&D at the National Center for Research Resources (NCRR) would restore part of the cut made last year. Programs important to chemists at NCRR include the Biomedical Research Technology Program, which would rise 6 percent to $48.9 million, and the Biomedical Research Support Program (BRSP), slated for flat funding of $22.9 million, down from $90.9 million in FY 1988. BRSP's Shared Instrumentation Grant Program would also remain flat at $8.8 million, down 73 percent from FY 1991.

Department of Defense

Funding for basic ("6.1" category) research is expected to increase 3 percent to $1.2 billion in the proposed budget for the Department of Defense. Within this total, support for academic chemical research funded through the defense research offices would not match inflation, increasing an estimated 1 percent to $38.1 million. All numbers are subject to change as stresses are felt from the Defense budget reductions still to be proposed by the

Administration. Additional funding for basic research in chemistry comes each year from other DOD programs and accounts.

For FY 1993, the Navy has two approved 5-year interdisciplinary initiatives—Molecular Interactions at Marine Interfaces (joint with Biology) to understand chemical, physical, and biological issues relating to bioadhesion on surfaces; and Adhesion Science (joint with Materials and Physics) to develop a theoretical and predictive basis for issues relating to adhesion. A third area added to the core program, Electrochemical Synthesis of Thin Films and Nanostructures, emphasizes issues related to the electrodeposition of semiconductor materials. The Air Force reports a new thrust in the synthesis of ceramic polymers.

Department of Energy

The overall FY 1993 budget for the Department of Energy would increase 2 percent to $19.4 billion. Emphasized areas are tied to the National Energy Strategy—energy efficiency and economy, energy security, and environmental quality—or to the FCCSET initiatives.

The so-called "science" budget, mostly Office of Energy Research (OER) programs, would appear flat without the proposed 34 percent increase to $650 million for the Superconducting Super Collider. Within OER,

- An increase of $13.7 million to $115.1 million is proposed for OER's Chemical Sciences Research. Within this increase, $3.1 million is targeted for Advanced Materials, $2.2 million for Biotechnology Research, and $5.0 million for applied research on advanced non-automotive batteries. The remainder would enhance priority areas within the current program. Facilities Operations increase 6 percent to $60.3 million.

- Materials Sciences Research would receive a 6 percent increase to $169.0 million in support of Advanced Materials (up an estimated $9.6 million) and Biotechnology

Research (up $0.3 million). Within the total, materials chemistry receives $4.1 million, up 21 percent. The Research component also contains preconstruction R&D support for the Advanced Neutron Source. The Facilities Operations budget increases 24 percent to $121.2 million.

- Programs involving chemistry under Biological and Environmental Research are slated to increase 26 percent to $27.2 million. Within this total, atmospheric chemistry research is expanded and another solicitation for university proposals would be announced.

While the request for Energy Conservation R&D would grow 24 percent to $366.4 million, Fossil Energy R&D faces the usual Administration reduction, down 30 percent to $311.3 million. Advanced Coal Research programs under Fossil Energy are scheduled for a reduction of 46 percent to $25.0 million. Within this total, University Coal Research and the Historically Black College initiative remain level in current dollars with FY 1992.

U.S. Department of Agriculture

At the U.S. Department of Agriculture (USDA), the National Research Initiative (NRI), a competitive grants program, is scheduled to receive a 54 percent increase to $150 million in FY 1993. Within NRI, funding is provided for priority initiatives that include mapping the genomes of important crop plants ($18.0 million), biofuels ($4.5 million), new uses for commodities ($18.3 million), global change ($10.4 million), water quality ($5.6 million), and human nutrition ($8.0 million).

These same research areas are among those funded in USDA's in-house laboratories which are under the Agricultural Research Service (ARS). The $668.4 million budget proposed for ARS research programs grows 4 percent over FY 1992. At the eight ARS laboratories supporting chemistry, research is up 3 percent to $193.8 million, and two of these laboratories undergo chemical wing modernization.

Environmental Protection Agency

The traditional purpose of the Environmental Protection Agency (EPA) research program is to support the agency's regulation of air and water quality, hazardous waste management, pesticides, toxic substances, and radiation. Increasingly, EPA is focusing resources on research to predict and avoid potential risks. The FY 1993 EPA budget requests an increase of 6 percent (2 percent over inflation) for the conduct of R&D to $525.9 million. This increase is considerably lower than last year's 13 percent request, and would still leave EPA supporting 11 percent less R&D than it did in FY 1980.

Owing to the regulatory nature of EPA's mission, almost all R&D activities entail some form of chemical support. For the first time this year, EPA funding is divided by environmental issues, making determination of the Agency's planned commitment to chemistry research difficult to determine at this stage of the budget process. This report discusses those issues, within the various EPA media, that appear to contain considerable chemical sciences activities.

The largest portion of EPA's research effort is devoted to Multimedia Research activities. These programs support cross-program issues, technology transfer, quality assurance and control, and EPA in-house research capabilities. As enforcement activities become more multi-issue in character, support for the multimedia research programs also would grow to 33 percent of the total R&D budget. Funding would increase 11 percent to $170.8 million. Multimedia programs of interest to chemists include:

- The Environmental Monitoring and Assessment Program (EMAP) would increase 73 percent to $45.0 million. The program is currently funding site-specific pilot projects that are amassing environmental data, and assessing techniques for collecting and interpreting that data.

- The Exploratory Research Grants program, which funds investigator-initiated research projects, is slated to decline 2 percent to $22.8 million.

- Funding for multimedia's risk assessment and exposure assessment research programs would grow 2 percent to $20.4 million.

- Multimedia's Pollution Prevention program would decline 9 percent to $5.0 million: however, across EPA, all pollution prevention research programs increase about 2 percent to $12.6 million.

- The broad Lead Abatement research program has been targeted for an 82 percent increase to $4.5 million.

Hazardous Waste Research and Superfund Research are slated to decline 3 percent to $108.7 million. These programs are designed to support regulation of hazardous wastes. Chemistry is an integral part of the efforts in waste identification, waste characterization, incineration, and alternate technologies. Specific work in the chemical treatment of waste streams is being funded through this last activity.

Air Research has been formally subdivided into air quality research, acid deposition research, and global change research. Programs to study air quality are proposed to increase 6 percent to $95.8 million. Most of the programs in this area involve a substantial amount of chemistry to develop estimation and characterization methodologies, and approaches to reduce emissions of target chemicals. The global change program is slated to rise 10 percent to $25.7 million. Acid deposition, which increases 11 percent to $14.9 million, includes work to estimate the pollution's point of emission.

Water research is divided into Water Quality Research and Drinking Water Research. Funding for research in these areas would grow 4 percent to $54.5 million. The water quality program expends a large amount of effort in R&D to develop techniques in water quality analysis, and water quality standards. The emphasis of the overall program is shifting from treatment technology to risk reduction and pollution prevention. Drinking water supports considerable chemistry concerning drinking water technology and protection of groundwater from agricultural run-off.

The 7 percent increase to $42.6 million for Toxic Substances Research and Pesticides Research also would support a considerable amount of chemical research. The test methods programs are developing and evaluating chemometric techniques to identify and quantify levels of pollutants in humans and the environment. These programs are projected to increase 24 percent to a total funding of $8.8 million. Funding for a prototype system to predict structure-activity relationships is requested to increase 13 percent to $1.9 million. Chemical marker research would be carried out through several other pesticides and toxic substances programs.

National Institute of Standards and Technology

As part of the Administration's focus on U.S. competitiveness, the National Institute of Standards and Technology (NIST) budget would increase 26 percent from $246.7 million to $310.7 million in FY 1993. Although the President committed last year to double the internal NIST budget over five years, large fractions of the FY 1993 increase are tied to the extramural program (up $19.2 million to $86.1 million) and to facilities needs ($22.7 million). The intramural program only rises $27.3 million to $201.9 million, with the largest growth tied to the FCCSET initiatives on Advanced Materials and High Performance Computing, as well as the expected new initiative for the next fiscal year—advanced manufacturing. Thus, within intramural programs, Computer Systems is slated to increase 48 percent to $17.5 million, and Manufacturing Engineering, up 37 percent to $13.0 million.

Less generous increases would be provided for other intramural programs. Materials Science and Engineering grows 11 percent to $38.6 million (including funding for the Cold Neutron Research Facility) to support research on advanced electronics packaging, advanced structural coatings and layered materials, and intelligent materials processing. Last year, no new funding was received from Congress for initiatives in chemical measurements and alternatives to Chlorofluorocarbons (CFCs). The FY 1993 budget for Chemical Science and Technology of $20.9 million, up 10 percent, includes $1.6 million to increase chemical measurements, biosensors, and semiconductor activities. However, the CFC activity did not make it through the agency-OMB budget process. The proposed increase for Physics of 8 percent to $28.2 million would expand investigations into the physics and chemistry of atomic clusters and nanometer sized structures.

Table I. Programs Supporting Chemistry at the National Science Foundation
(budget authority in millions)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request	% Change FY 92/93
Chemistry Division				
Analytical & Surface	$13.66	$14.39	$15.70	9.1%
Inorganic, Bioinorganic & Organometallic	17.63	18.34	20.65	12.6%
Organic & Macromolecular	25.92	27.00	29.87	10.6%
Physical Chemistry	30.63	32.50	35.16	8.2%
Special Projects	8.77	14.00	18.47	31.9%
Chemical Instrumentation	8.10	6.10	6.10	0.0%
Subtotal, Chemistry	$104.71	$112.33	$125.95	12.1%
Materials Research Division				
Materials Research Project Support	$69.18	$77.40	$96.35	24.5%
Materials Research Laboratories & Groups	47.19	47.99	51.44	7.2%
National Facilities & Instrumentation	17.76	18.20	19.70	8.2%
Subtotal, Materials Research	$134.13	$143.59	$167.49	16.6%
TOTAL	$238.84	$255.92	$293.44	14.6%

Source: National Science Foundation

Table II. Programs Supporting Chemistry at the Department of Energy
(budget authority in millions)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request	% Change FY 92/93
Basic Energy Sciences (BES) Programs				
Chemical Sciences Research[a]	$95.34	$101.40	$115.10	13.5%
Materials Chemistry Research	20.70	19.60	23.70	20.9%
Geochemistry Research	5.95	7.20	7.50[b]	4.2%
Other Programs				
Biofuels Energy Systems[c]	$14.00	$18.20	$34.10	87.4%
Biological and Environmental Research[c]	19.95	21.50	27.15	26.3%
Conservation[c]	12.84	11.58	10.83	-6.5%
Fossil Energy - Chemistry	27.52	26.39	19.03[b]	-27.9%
University Research Instrumentation	4.83	5.00	5.65	13.0%
TOTAL, ALL PROGRAMS INVOLVING SOME CHEMISTRY - OPERATING EXPENSES	$201.13	$210.87	$243.06	15.3%

[a] Includes atomic physics and chemical engineering
[b] Estimate
[c] Includes subelements funding some chemistry

Source: Department of Energy

Chapter 19

Behavioral and Social Research in the FY 1993 Budget

Federation of Behavioral, Psychological & Cognitive Sciences, Claudia Feller

American Psychological Association, Barbara J. Calkins

American Educational Research Association, Marcia Knutson

Research in the behavioral and social sciences can be found in federal agencies ranging from the Department of Health and Human Services to the Department of Defense. Highlights of the FY 1993 budget proposal for relevant programs are represented in Tables 1-4 in this chapter and the brief analyses of selected programs that follow.

Department of Health and Human Services (HHS)

The Administration's FY 1993 HHS budget emphasizes prevention. The emphasis is seen in some modestly increased commitments to the delivery of preventive services, but does not appear to include a research agenda. The good news is that the Administration's HHS budget again focuses on issues related to behavior change--the hallmark of the behavioral and social sciences--as the key to prevention and better health for all Americans. The bad news is that the Administration's approach to the issue is to shame Americans into taking personal responsibility for their health behaviors, chiding them to simply "stop" the harmful ones (i.e., smoking, eating a high fat diet, engaging in risky sexual practices, having accidents that result in injury, etc.). While such changes would, in fact, save a lot of health care dollars, the Administration's budget does not propose a research agenda for meeting the challenge of changing those high risk, intractable human behaviors.

National Institutes of Health (NIH)

In April of 1991, Dr. Bernadine Healy assumed the directorship of the National Institutes of Health (NIH), bringing with her strong convictions and clear objectives--objectives that, she states publicly, include behavioral research. For the first time in recent memory a Director of NIH is saying that "biobehavior [is] as important as biochemistry and molecular biology." Healy speaks of "intensifying" NIH health and behavior research and of the increasing importance of health-enhancing behaviors in our efforts to conquer disease.

For NIH, the Administration requests an overall increase of 5 percent or $443 million, bringing the total request to $9.4 billion. The research projects line at NIH would increase 7 percent. Will a proportionate share of that increase go to the behavioral and social sciences under Healy's stewardship? It is difficult to say with certainty. What we do know is that most of the NIH research institutes do support or conduct behavioral research, exploring behavioral and social factors in health promotion, disease prevention, treatment, and child development and aging processes. Yet the funding for this research, as a proportion of the overall NIH budget, has remained relatively flat for many years.

The congressionally mandated plan for proportionally increasing health and behavior research funding at NIH was delivered in November of 1991. The data showed that in FY 1990, NIH funded an estimated $309 million in health and behavior research. The report estimated a $335 million expenditure in FY 1991, and requested $359.1 million for FY 1992--holding steady at 4 percent of the NIH overall budget. (See Table 1 below for the latest figures on the NIH health and behavior research commitment.)

Table 1. NIH Health & Behavior Research (dollars in thousands)

	FY 1991 actual	FY 1992 estimate	FY 1993 budget	% change FY 1992-93
NCI	$ 71,172	$ 80,173	$ 82,616	3.1
NHLBI	54,692	59,100	64,100	8.5
NIDR	5,841	6,274	6,597	5.2
NIDDK	16,000	17,100	18,000	5.3
NINDS	16,432	17,582	18,577	5.7
NIAID	7,579	7,882	8,198	4.0
NIGMS	3,262	3,569	3,819	7.0
NICHD	51,900	56,000	59,000	5.4
NEI	4,902	5,147	5,404	5.0
NIEHS	3,292	3,417	3,544	3.7
NIA	56,541	59,368	61,149	3.0
NIAMS	8,431	9,089	9,356	2.9
NIDCD	6,674	7,279	7,724	6.1
NCRR	26,823	23,574	23,640	0.3
NCNR	17,755	20,000	21,600	8.0
OD	0	0	0	0.0
FIC	0	0	0	0.0
NLM	2,443	2,650	2,749	3.7
Total	$353,739	$378,204	$396,073	4.7

Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA)

The National Institute of Mental Health (NIMH), housed along with the National Institute on Drug Abuse (NIDA) and the National Institute on Alcohol Abuse and Alcoholism (NIAAA) under the aegis of the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), provides the lion's share of funding for behavioral research on mental health and disability.

Although the Administration's budget proposes a 6.5 percent increase in funding for NIMH's research, 5.8 percent for NIDA's research, and 4.8 percent for NIAAA's research, it is the medications development research activities at each of those institutes that would see the greatest benefit of the increases. Those efforts are slated for a 13 percent increase over FY 1992 levels, for a total of $63.5 million in FY 1993.

The total ADAMHA budget request for research is $1.1 billion, an increase of $61.7 million or 5.8 percent over FY 1992. Within the overall research budget, research project grants would increase by 7.1 percent. According to ADAMHA, this increase would "expand [their] capacity to develop effective medications for ADM disorders and continue implementation of established national plans addressing Schizophrenia, the Decade of the Brain, Research to Improve Care for the Severe Mental Disorders, Child and Adolescent Research, Drug Strategy IV, and Alcohol Genetic Research."

Centers for Disease Control (CDC)

Research activities under the aegis of the Centers for Disease Control (CDC) include surveillance, epidemiology, laboratory evaluation, and applied population-based research related to the personal behavior choices that lead to disease and unintentional injury. With the exception of the HIV program, which is recommended for a 5 percent increase, the Administration requested level funding for most other CDC research activities.

* * *

See Table 2 (on the following page) for some items of interest to social and behavioral scientists in the FY 1993 budget proposals for ADAMHA, NIH and CDC.

Table 2. Department of Health & Human Services (budget authority in millions)

	FY 1991 actual	FY 1992 estimate	FY 1993 budget	% change FY 1992-93
ADAMHA				
NIMH RPGs	$263.7	$289.3	$311.0	7.5
NIDA RPGs	174.3	177.1	189.7	7.1
NIAAA RPGs	85.9	97.2	102.9	5.9
NIH				
NCI Cancer Prevention & Control	85.4	106.2	91.1	-14.2
NHLBI Heart & Vascular Diseases	439.2	466.2	498.5	6.9
NINDS Biological Basis Research	253.4	262.7	281.3	7.1
Clinical Research	117.3	135.3	144.9	7.1
NICHD Research for Mothers & Children	183.9	192.5	206.0	7.0
Population	85.2	89.4	96.2	7.6
Medical Rehabilitation Research	0.0	4.6	4.9	6.5
NIA Aging Research	191.0	234.4	255.2	8.9
CDC				
Prevention Research Centers	4.4	5.2	5.2	0
Occupational Safety & Health	97.0	103.4	84.6	-18.2
Sexually Transmitted Diseases	73.6	77.5	77.6	-
Chronic & Environmental Diseases	51.4	67.7	66.9	-1.2
Injury	24.0	27.4	27.5	-
Health Statistics	52.4	51.3	50.6	-1.4
HIV	497.0	480.1	504.7	5.1

Note: This table represents total funding (not just behavioral and social). In addition, the ADAMHA and NIH figures represent research projects only--not centers, training, contracts, intramural, management, support, etc.

Table 3. National Science Foundation (budget authority in millions)

	FY 1991 actual	FY 1992 estimate	FY 1993 budget	% change FY 1992-93
SOCIAL, BEHAVIORAL & ECONOMIC SCIENCES				
Social & Economic Science				
Economics	$15.0	$17.5	$20.7	18.3
Geography	3.6	4.0	4.8	21.5
Sociology	4.4	4.7	5.6	20.4
Meth, Meas & Statistics for the Social Sciences	2.5	2.8	3.6	28.9
Political Science	4.3	4.8	5.8	19.8
Law & Social Science	2.4	2.7	3.4	28.1
Decision, Risk & Management Science	3.8	4.2	5.3	27.7
Behavioral & Cognitive Sciences				
Anthropology	8.8	9.5	10.2	7.3
Language, Cognition & Social Behavior	11.9	12.7	14.6	15.4
International Cooperative Scientific Activities				
International Cooperative Scientific Activities	12.8	12.6	14.9	18.3
Science Resources Studies				
Studies of Science & Engineering Resources	5.9	6.8	14.5	12.7
Studies in Science, Technology & Society	4.0	3.7	4.4	16.6
BIOLOGICAL SCIENCES				
Physiology & Behavior	27.9	30.4	35.3	16.2
Neuroscience	29.1	30.6	33.7	10.1
COMPUTER & INFORMATION SCIENCE & ENGR				
Knowledge & Database Systems	9.8	12.4	17.1	38.4
Robotics & Machine Intelligence	6.6	6.7	8.7	30.1
Interactive Systems	3.0	3.3	5.0	51.5
Information Technology & Organizations	4.1	4.7	6.1	30.1

National Science Foundation (NSF)

On October 11, 1991, NSF announced that two distinct directorates would be established to replace the Directorate of Biological, Behavioral and Social Sciences (BBS). One of these would be devoted to research in the social, behavioral and economic sciences; the other, the biological sciences. Thus, the FY 1993 budget proposal is the first to include the new Social, Behavioral and Economic Sciences (SBE) Directorate. In addition to funding social, economic, behavioral and cognitive sciences, SBE houses the Science Resources Studies programs (surveys and data collection) and international programs. Both were previously found in the former Directorate for Scientific, Technological and International Affairs (STIA).

The $107.8 million FY 1993 SBE request is $21.9 million or 25.5 percent over the FY 1992 appropriation. The proposal will provide for the continuing development of NSF's initiative in cognitive science. The $7.7 million increase (+112.7 percent) requested for Studies of Science and Engineering Resources would support the post-censal study of the scientific and engineering workforce. The $2.3 million increase (+18.3 percent) requested for International Cooperative Scientific Activities would go to support the activities and goals of the International Institute for Applied Systems Analysis.

A significant portion of the proposed SBE increase would support the FY 1993 U.S. Global Change Research Program, the first but now one of five interagency research initiatives. At SBE, economics research on global change would increase from $3.4 million in FY 1992 to $6.0 million in FY 1993; research on human dimensions of global change would go from $3.4 million to $4.8 million. NSF will sponsor projects to analyze factors that influence human population dynamics, e.g., rapidly changing economic and environmental conditions that affect migration. NSF currently supports efforts by the Energy Modeling Forum to tie key policy analysis issues on global environmental change to the basic social science needed to improve existing economic models. Among new NSF projects are models of economic effects of greenhouse gas restrictions on developing countries, models of trade and environment, and studies of short- and long-term determinants of growth. NSF will give attention to comparative analyses of risk assessment and decision-making procedures in different types of institutions and the determination of means whereby intangible costs and benefits may be more effectively integrated into decision-making. NSF is also emphasizing basic research needed to provide better tools for analyzing the types of risks associated with global change.

SBE would also participate in the new interagency Biotechnology Research Program, which includes research on the social, ethical, economic and legal issues associated with biotechnology research, development, adoption or utilization. The budget proposal includes $1.3 million for biotechnology social impact research at NSF.

Behavioral and social scientists find funding in other NSF directorates--Biological Sciences (BIO), Computer and Information Science and Engineering (CISE), and Education and Human Resources (EHR). EHR details are found elsewhere in this volume. Before SBE, the behavioral and neural sciences were housed in the same division. Now, despite some protests, neuroscientists are in the new BIO Integrative Biology and Neurosciences Division. The budget request includes very large increases for the Information, Robotics & Intelligent Systems (IRIS) Division in CISE, largely driven by participation in the interagency high performance computing initiative. Priorities are also maintained for research on language and speech processing and for research on computer-based technologies to facilitate collaboration among organizations and individuals. (See Table 3 in this chapter.)

Department of Defense (DOD)

DOD is a major supporter of behavioral and social science research; most is categorized as "human resources technologies"--manpower, personnel, training and human factors in systems. Emphasis is on the immediate questions and needs of the services. DOD research is classified by type of effort (6.1, basic research;

6.2, exploratory development; 6.3, advanced development; and 6.4, prototype development).

FY 1993 funding for the Air Force Office of Scientific Research (AFOSR) would be $237.4 million, up from the FY 1992 actual of $206.2 million. The proposed increase, however, contains at least $17 million in set-asides. Funding for behavioral science work in AFOSR's Life and Environmental Sciences Directorate would go up from the FY 1992 actual of $10.5 million to the FY 1993 request of $11.5 million.

At the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), the budget for 6.1 or basic research would go from $3.4 million in FY 1992 to $4 million for FY 1993. Funding for 6.2 or exploratory development would go from $15.8 million to $16.2 million. Funding for 6.3 or advanced development would go from $14.4 million to $16.7 million. In FY 1993, ARI is also proposing to spend $3.6 million for personnel and training analyses activities within 6.5 management support (as opposed to $3.2 million in FY 1992).

The Office of Naval Research (ONR) Cognitive and Neural Sciences Division (6.1) would go from $16.9 million in FY 1992 funds to an estimated $16.4 million in FY 1993 under the current proposal.

Department of Education

Research programs in the Department of Education are primarily under the jurisdiction of the Office of Educational Research and Improvement (OERI), which is also responsible for assessment, statistics and numerous small improvement programs. For FY 1993, the Administration has requested huge increases for some OERI programs: 62 percent for research, 116.7 percent for assessment and 34.4 percent for statistics. Most of the proposed increase for research, however, is slated for assessment and dissemination activities, with the basic research programs receiving minimal or no increases.

OERI's research components include the national education research and development centers, each of which focuses on a particular set of education problems; regional education laboratories, which provide technical assistance in support of school improvement activities; the Education Resources Information Center (ERIC) system; and field-initiated studies. Under the FY 1993 budget proposal, existing centers and laboratories would receive funds for continuation activities already planned, but no new competitions are planned for the three centers completing their grants. Field-initiated studies would double to $2 million.

In FY 1993, the Administration would spend $40 million of the proposed $44 million increase in the research account for "standards, curriculum frameworks and assessments," and "access to research through technology." Activities relating to the National Council on Education Standards and Testing's recommendations would receive $25 million of that $40 million. The other $15 million would go to a major effort to use technology to expand the access of schools and communities to knowledge gained from research, including SMARTLine, a new database that would be accessible either through using a modem or by calling a toll-free number. SMARTLine would contain information about the best research, programs and practices, as well as references to education improvement activities.

Separate from the new assessment proposals in the research account, the Administration proposes a 116.7 percent increase in OERI's assessment line, whose primary activity is the congressionally mandated National Assessment of Educational Progress (NAEP). The proposed increase includes funds for the states to conduct assessments in grades 4, 8 and 12 in math, science and reading, as recommended by the National Assessment Governing Board and the National Academy of Education. The states would receive only $4.8 million of the assessment total of $64.8 million. Basic NAEP operations would increase $27.5 million or 112.2 percent for FY 1993, a 234.8 percent increase from just two years ago.

The National Center for Education Statistics (NCES) collects, analyzes and reports statistical data in education. The FY 1993 budget requests a 34.4 percent, or $16.3 million, increase for NCES. These additional funds would enable NCES to collect more comprehensive data including data on private schools as well as education and training outside traditional settings.

The Eisenhower Mathematics and Science Education National Programs are also housed at OERI and are slated for a 250 percent increase to $56 million. These programs are among the beneficiaries of the Administration's math and science priorities and tie directly to one of the National Education Goals. Eisenhower programs assist in the development of teacher training programs in math and science, as well as model programs within school districts.

The FY 1993 request also includes $12 million for Eisenhower Regional Consortia. This program was included in the final FY 1992 appropriation, but had never been funded prior to that and was not in last year's budget request. These funds would help to disseminate math/science instructional materials and provide technical assistance in teaching methods. At least one consortium would be designated for each regional lab area.

Table 4. Education Research & Improvement (dollars in millions)

	FY 1992 estimate	FY 1993 budget	% change FY 1992-93
RESEARCH	$71.0	$115.0	62.0
Standards, Curriculum Frameworks & Assessments	0.0	25.0	-
Access to Research Through Technology	0.0	15.0	-
Research Centers	25.3	27.7	9.5
Regional Laboratories	35.0	31.9	-8.9
ERIC System	7.2	7.2	0
Field-Initiated Studies	1.0	2.0	100.0
ASSESSMENT	29.9	64.8	116.7
STATISTICS	47.3	63.6	34.4
EISENHOWER MATH/SCIENCE	28.0	68.0	142.9
National Programs	16.0	56.0	250.0
Regional Consortia	12.0	12.0	0

Chapter 20

Federal Statistics in the FY 1993 Budget

Council of Professional Associations on Federal Statistics

Katherine K. Wallman

Overview

Statistics produced by the federal government serve as a base for research in a broad spectrum of scientific disciplines. Population and vital statistics are central to the work of political scientists and demographers; employment, financial, and production data are essential for economists; and information on education and crime is used by sociologists and psychologists.

Researchers in the social sciences are not alone in their reliance on federal statistics. Epidemiologists and biostatisticians depend on data from the National Center for Health Statistics and the National Institutes of Health; meteorologists rely on information compiled by the National Oceanic and Atmospheric Administration; and scientists in an array of professions employ statistics that are gathered and distributed by agencies such as the National Science Foundation, the Energy Information Administration, the Environmental Protection Agency, the Soil Conservation Service, and the Geological Survey.

Responsibility for the collection, analysis, and dissemination of federal statistics is spread throughout the departments and independent agencies of the executive branch; each of some 70 agencies and departmental units annually spends $500,000 or more on statistical activities. Within this decentralized system that generates statistical information, a more limited number of agencies have the creation of statistics as their principal mission. It is these agencies, which are responsible for producing statistics on major economic, demographic, and social developments and trends, that are the focus of discussion in this chapter.[1]

For FY 1993, funding levels that have been proposed for the principal statistical agencies in several cases would provide significant increases over the resources appropriated in FY 1992.[2] In particular, the Administration's proposal for FY 1993 continues to place special emphasis on activities to strengthen economic statistics, implementing a multi-year initiative recommended by the Economic Policy Council and approved by the President. This initiative, which would provide a funding increase of more than $150 million over the five-year period 1993-1997, includes activities to modernize the National Income and Product Accounts to improve their accuracy, breadth, and international comparability; improve the coverage and detail of international flows of funds; separate quality and inflation changes in price data; and increase coverage of the service sector. The proposed budget also includes a substantial increase for education statistics, to assess progress in implementing the America 2000 strategy and in reaching the National Education Goals as well as to meet legislative requirements for improved data. In addition, funding is requested to continue activities to monitor health trends and the use of health services, and to explore relationships between risk factors and disease; to implement new criminal justice information programs; and to extend planning for the year 2000 decennial census. The balance of this chapter provides further details on FY 1993 budget proposals for the principal statistical agencies.

Bureau of the Census

The Bureau of the Census collects, compiles, and publishes general purpose statistics on the population and the economy. Budget authority for the Census Bureau is provided in two appropriations: one covers "current programs," including demographic surveys, international programs, and data on construction, manufacturing, retail and wholesale trade, services, foreign trade, and state and local government finances and employment; the other covers "periodic programs," including the decennial census of population and housing, intercensal estimates of population, and the quinquennial economic censuses, census of governments, and census of agriculture. For FY 1993, the proposed $138.4 million level for the current programs budget provides an increase of $13.1 million over FY 1992, an amount that would permit the Census Bureau to continue its base programs and to implement portions of the initiative to improve economic statistics. Proposed activities related to statistics on the service sector include improving the measurement of services purchased by industry, improving small company financial data, expanding corporate financial data, and collecting annual detail for more service industries. Other initiatives to improve economic statistics include expanding coverage of nonresidential building construction, designing a survey to collect nonresidential building price information, and developing new techniques to measure construction at manufacturing and industrial sites; developing and maintaining a list sharing arrangement to improve the quality and timeliness of information about establishments; providing statistics to improve the analysis of economic impacts of environmental policies; and developing a model to reduce the undercounting and undervaluing of exports. [For information concerning the proposed FY 1993 budget for Census periodic programs, see the table at the end of this chapter.]

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[1] The publication date for this report precludes completion by other agencies of the analyses required to present budget data for their "statistical" activities.

[2] For details of the funding history in fiscal years 1991 through 1993, see the table at the end of this chapter.

Bureau of Labor Statistics

The Bureau of Labor Statistics collects, analyzes, and disseminates data on employment and unemployment; prices and living conditions; consumer expenditures; wages and employee benefits; industrial relations activities; productivity and technological change in U.S. industries; projections of economic growth, the labor force, and employment by industry and occupation; and occupational injuries and illnesses. For FY 1993, the proposed budget for BLS is $333.9 million, a rise of $32.8 million over the estimated level for 1992. While slightly more than half of the FY 1993 increase reflects the transfer of funding for the Occupational Safety and Health Statistics program from the Occupational Safety and Health Administration to BLS, and much of the balance would be used to cover mandatory increases for ongoing programs, the proposed budget would support continuation of activities related to the economic statistics initiative, the Federal Employees Pay Comparability Act of 1990, and the multi-year redesign of the Current Population Survey. Activities to improve economic indicators would include expansion of service sector coverage in monthly employment estimates and in the International Price Index and Producer Price Index; the introduction of computer-assisted data collection in additional states to allow more firms to be included in preliminary monthly employment estimates; and the institution of measures in the Producer Price Index to improve the quality of data for rapidly changing industries and to distinguish more clearly between differences attributable to quality changes and those that reflect solely changes in price. To address requirements for data to support federal pay determinations, the budget requests resources to continue survey activities begun in FY 1992 and to prepare results from those surveys for the President's Pay Agent. The proposed increment for the Current Population Survey would be used to implement an overlap sample that will permit BLS to distinguish changes due to the use of the revised questionnaire from those due to changes in the economy. In order to provide resources to continue the BLS series having the highest priority, the FY 1993 budget proposes to eliminate the Foreign Direct Investment program, and to postpone new industry wage studies until pay reform surveys have been established. The proposed BLS budget does not include resources for the Mass Layoff Statistics program, which was supported in FY 1992 as Congress directed on a reimbursable basis by the Employment and Training Administration.

Bureau of Economic Analysis

The Bureau of Economic Analysis prepares and interprets the United States economic accounts. These include the national income and product accounts, summarized by Gross Domestic Product [GDP], as well as wealth accounts, input-output accounts, and measures relating to environmental change; the international economic accounts, consisting of the balance of payments and associated foreign investment accounts; and the regional economic accounts, consisting of personal income measures by state and county. This work is supplemented by a system of business indicators. For FY 1993, BEA's proposed budget authority would rise by $15.8 million over the FY 1992 level, to a total of $50.5 million. While almost half of the requested increase would be used to relocate BEA to new quarters, funding for several activities related to the economic statistics initiative is included in the proposed budget. Increased resources for the national economic accounts would be used to strengthen evaluation and planning efforts for the United States' move to the United Nations' System of National Accounts; extend the national accounts to include a full set of accounts for the household, business, government, and rest-of-the-world sectors; and expand efforts on satellite accounts. Proposed funding for the international economic accounts would support activities to improve measurement of international portfolio investment and other capital flows; to modernize and extend the accounts for consistency with the forthcoming revision of the International Monetary Fund's Balance of Payments Manual; and to extend coverage of data on international trade in financial services. To address immediate quality issues in the national and international economic accounts, the proposed BEA budget includes funding for the development and acquisition of new and improved source data.

Statistics of Income, Internal Revenue Service

The IRS Statistics of Income program provides annual income, financial, and tax related data for individuals, corporations, partnerships, sole proprietorships, and tax-exempt organizations, as well as special studies for the Office of the Secretary of the Treasury, including those in support of Congressional mandates. For FY 1993, a total budget authority of $22.8 million is proposed for the SOI program, an amount essentially equal to the FY 1992 level of $22.5 million. No major program changes are planned for SOI in FY 1993. Instead, innovations continue to be concentrated on a number of initiatives designed to further improve data quality and timeliness and to more efficiently process information.

National Agricultural Statistics Service

The National Agricultural Statistics Service collects and reports data on a wide range of agricultural characteristics, including crop and livestock production, inventories, prices paid and received by farmers, costs of production, farm labor usage and wage rates, agricultural chemical use, and other agricultural statistics. For FY 1993, the proposed budget authority for NASS is $87.1 million, an increase of $4.5 million over FY 1992. Funding at this level would allow NASS to significantly expand the fruit, nut, and vegetable chemical use surveys to provide more useful and current information for the Pesticide Data Program [formerly the Food Safety Initiative]; to begin development and maintenance activities associated with a long-term plan to enhance the NASS area sampling frame; and to expand development of surveys and reports on the whole farm utilization of restricted use pesticides, including livestock, pastures and other farm areas not included in crop specific pesticide surveys. A proposed decrease in funding for specialty commodity statistics will delay implementation of regular inventory surveys of fruit trees and vines, leaving these studies on a intermittent basis.

Economic Research Service, USDA

The Economic Research Service is responsible for research, situation and outlook analysis, staff analysis, and development of economic and statistical indicators in four major program areas: commodity economics, agriculture and trade analysis, resources and technology, and agriculture and rural economy. For FY 1993, a funding level of $60.4 million is proposed for ERS, an increase of $1.7 million over FY 1992. Program activities that would be supported by the requested increase include food safety research, pesticide data and analysis, and evaluation of nutrition education programs. Resources for the rice modeling study will be reduced.

Energy Information Administration

The Energy Information Administration collects, analyzes, and disseminates data on energy resources, production, distribution, consumption, technology, and related international, economic, and financial matters. EIA produces reports with statistical time series, projections of future energy trends, and analyses of topical energy issues, and supports the information needs of the Department of Energy. EIA's proposed budget for FY 1993 is $81.7 million, an increase of $5.5 million over FY 1992. Funding at the proposed level would allow the agency to continue its basic programs, as well as to respond to increased demands for energy information and analysis. A key initiative would continue development of the National Energy Modeling System which will provide forecasts of alternative energy futures in the mid- and long-term periods, and illustrate the energy, economic, environmental, and energy security consequences of alternative energy policies and assumptions. The proposed budget also would allow for the conduct of the triennial Residential Energy Consumption Survey; the continuation of a project to redesign end-use survey samples; the modification of several survey forms and associated data systems and publications to respond to the Clean Air Act Amendments; and the addition of data and analyses on demand-side management, impacts of new technologies, and energy efficiency in the U.S. economy.

National Center for Health Statistics

The National Center for Health Statistics monitors the nation's health and use of health services and explores relationships between risk factors and disease. Data sources include the nation's vital statistics system and surveys involving personal interviews, physical examinations and laboratory testing, and information from health care providers. For FY 1993, the Administration budget proposes total funding of $84.8 million for the center's programs, an increase of $4 million over the amount appropriated in FY 1992. Funding at the proposed level includes resources for NCHS to conduct the annual National Health Interview Survey at the full sample size of 50,000 households [but does not include resources for the major special topics questionnaire scheduled to focus on disability]; to collect data in the periodic National Survey of Family Growth and National Mortality Followback Survey; to continue the multi-year National Health and Nutrition Examination Survey; to support the National Vital Statistics System, including components measuring births, deaths, marriages, divorces, and induced terminations of pregnancy; to conduct the National Health Care Survey, which includes annual data collection from hospitals and from physicians in private offices, emergency rooms, and outpatient clinics, as well as research to expand the coverage and utility of this survey; and to make awards for a second year under the NCHS minority health statistics grants program, which was authorized by the Minority Health Improvement Act of 1990. Also included in the FY 1993 request is funding for continued work, on a scale reduced from the center's initial plans, to improve the timeliness and quality of health data through expanded use of automation and technology in various phases of NCHS data collection, processing, and dissemination.

National Center for Education Statistics

The National Center for Education Statistics collects, analyzes, and reports statistics on education in the United States; conducts studies on international comparisons of education statistics; and provides leadership in developing and promoting the use of standardized terminology and definitions for the collection of those statistics. For FY 1993, a budget of $128.4 million is proposed, an increase of $51.2 million over FY 1992. Of this total, $64.8 million would support the National Assessment of Educational Progress [NAEP]; the balance would fund the Center's ongoing programs, as well as activities initiated pursuant to mandates of the Elementary and Secondary School Improvement Amendments of 1988 and requirements stemming from the National Education Goals. The substantial increase in resources for NAEP would support expanding state-representative assessment activities including analyses of data from 1992 assessments of mathematics in grades 4 and 8 and reading in grade 4 as well as further analyses of the 1990 assessment data. Also included in the budget request are resources to develop the 1994 assessments at grades 4, 8, and 12 in reading, mathematics, science, U.S. history, and geography. Increases proposed for other programs of NCES would support development of the Third International Mathematics and Science Study and of new methodologies for assessing elementary/secondary and postsecondary education; implementation of the third cycle of the Schools and Staffing Surveys; gathering of expanded data on school finance, staff, and dropouts through the Common Core of Data; collection of data on early childhood experiences and school discipline through the National Household Education Survey; and a pilot administration of the Graduate Record Examination to a sample of college students included in the Postsecondary Student Aid Study as an initial attempt to assess college achievement.

Bureau of Justice Statistics

The Bureau of Justice Statistics is responsible for collecting, analyzing, and disseminating information on crime, victims of crime, criminal offenders, and operations of justice systems at all levels of government. For FY 1993, the proposed budget authority is $24.2 million, an increase of $2.1 million over FY 1992. The requested funding level includes resources to conduct the National Probation and Parole Survey, the first study of offender populations serving sentences under conditional supervision that would produce nationally representative data on offender characteristics, current offenses, prior criminal histories, drug use histories and drug testing experiences, and the nature of supervision based on past criminal behavior or drug use. In addition, the proposed BJS budget includes funding to establish an ongoing statistical series to measure intentional injuries with a focus on obtaining a measure of the incidence of family violence and child abuse serious enough to result in a visit to a hospital emergency room. Funding requested for FY 1993 also would support reinstatement of the biennial Criminal Justice Expenditure and Employment Survey, to provide information on costs of the justice system and produce the data necessary to ensure that formula funds are equitably allocated among state and local governments under the Edward Byrne Memorial State and Local Law Enforcement Assistance Program.

Principal Federal Statistical Agencies
(total direct funding in millions)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Budget
Bureau of the Census (current programs)[1]	$111.2	$125.3	$138.4
Bureau of Labor Statistics	255.2	301.1	333.9
Bureau of Economic Analysis	31.5	34.7	50.5
Statistics of Income, IRS	22.2	22.5	22.8
National Agricultural Statistics Service	76.5	82.6	87.1
Economic Research Service, USDA[2]	54.4	58.7	60.4
Energy Information Administration	68.9	76.2	81.7
National Center for Health Statistics[3]	70.4	80.8	84.8
National Center for Education Statistics[4]	63.5	77.2	128.4
Bureau of Justice Statistics[4]	22.1	22.1	24.2

Notes: [1] The proposed FY 1993 budget for periodic programs at the Bureau of the Census is $200.0 million; these funds would be used to continue analysis and dissemination of 1990 decennial census data, accelerate planning for the year 2000 decennial census, and conduct the 1992 Economic Censuses. [2] Approximately 20 percent of the Economic Research Service budget, shown here in total, is used for surveys, data collection, and preparation of statistical reports. [3] Funding levels shown for NCHS include $19.0 million in FY 1991, $29.4 million in FY 1992, and $34.2 million in FY 1993 from Public Health Service Evaluation Funds. [4] Funding levels shown for NCES and BJS do not include S&E from other departmental sources; for FY 1993, NCES will have an estimated $14.0 million in S&E budget, and BJS will have an estimated $3.5 million in S&E budget.

Chapter 21

Mathematical Sciences in the FY 1993 Budget

Joint Policy Board for Mathematics

Lisa Thompson

Overview

- Federal support for the mathematical sciences in FY 1993 will total approximately $173 million, which is roughly 3 percent more than the FY 1992 total; adjusting for inflation, FY 1993 funding is not expected to rise above the FY 1992 level.
- The NSF budget request for the mathematical sciences is 8 percent higher in FY 1993 than in FY 1992; as the increment is targeted for cross-disciplinary and computational mathematics and special projects, proposed funding for disciplinary mathematics remains at the FY 1992 level.
- DOD support for the mathematical sciences is projected to decline slightly; in real terms, it will drop to below the FY 1991 level.
- Proposed FY 1993 funding for the mathematical sciences at DOE is constant at the FY 1992 level; adjusting for inflation, non-NSF support for the mathematical sciences will likely drop to below the FY 1990 level.
- The Presidential Research Initiatives and other interdisciplinary research activities are becoming increasingly important in determining the nature of federally supported mathematical research.

Trends in Federal Support for the Mathematical Sciences

For the last five years or so, federal support for the mathematical sciences has been growing at an annual rate of just 2 or 3 percent above inflation. Budget crunches in both the domestic and defense sectors and shifts in federal R&D priorities--which increasingly emphasize large science projects and targeted research programs--have conspired to bring to a close the expansion of federal mathematical sciences programs during the early and mid-1980's.

The most notable feature of recent federal funding for the mathematical sciences is the increasing degree to which it is influenced by the Presidential Research Initiatives and other multidisciplinary activities. These initiatives provide the field with new opportunities and resources in the context of important national science and technology goals. However, slower growth in overall funding for the mathematical sciences combined with expansion of cross-disciplinary activities raises questions about the adequacy of support for research in core mathematics.

It should be noted that the increasingly quantitative nature of research in general hinders the complete accounting of federal support for mathematical scientists. For instance, beginning in FY 1992, a new NSF-wide activity will make awards to HPCC Grand Challenges Applications Groups, multidisciplinary teams seeking to apply high performance computing techniques and resources to fundamental problems in science and engineering with broad economic and scientific impact. The involvement of the mathematical sciences in such an activity would not necessarily be reflected in the spending figures presented here.

Federal Support for the Mathematical Sciences in FY 1993

In FY 1993, combined spending by the seven mathematical sciences programs is projected to grow by a little more than 3 percent above the FY 1992 level. As this is the expected rate of inflation, it appears that federal support for the mathematical sciences will experience no real growth in FY 1993.

This result arises from the combined effects of proposed spending increases by the National Science Foundation and the Office of Naval Research and relatively flat spending or projected decreases by the other programs at the Department of Defense, including a sharp drop in funding from the Defense Advanced Research Projects Agency.

The table on the next page gives budget figures for the seven federal mathematical sciences programs, including estimates of FY 1992 spending and of proposed spending for FY 1993. The FY 1993 proposals are subject to the congressional budget process and to future revision by the responsible agencies. All figures shown in the table and cited below are in terms of current dollars.

Each funding agency provides support for a variety of activities including individual and group awards, institutes, equipment, and education and human resources development. Thus, the figures given are

FEDERAL SUPPORT FOR THE MATHEMATICAL SCIENCES
FY 1990-1993, in millions, current dollars

	actual FY 90	actual FY 91	current plan FY 92	budget request FY 93	percent change FY92-93
National Science Foundation	**77.12**	**81.15**	**86.58**	**92.95**	**7.4%**
DMS	69.12	73.15	78.58	84.95	8.1%
Other	8.00	8.00	8.00	8.00	0.0%
Department of Defense	**59.11**	**64.70**	**66.56**	**65.76**	**-1.2%**
AFOSR	16.50	17.00	17.00	17.00	0.0%
ARO	12.00	13.50	13.50	14.00	3.7%
DARPA	14.75	17.02	18.67	16.05	-14.0%
NSA	3.40	3.10	3.00	3.00	0.0%
ONR	12.46	14.08	14.39	15.71	9.2%
Department of Energy	**12.90**	**13.20**	**13.50**	**13.50**	**0.0%**
University Support	6.40	6.70	5.40	5.40	0.0%
National Laboratories	6.50	6.50	8.10	8.10	0.0%
Other Agencies	**1.00**	**1.00**	**1.00**	**1.00**	**0.0%**
TOTAL, All Agencies	**150.13**	**160.05**	**167.64**	**173.21**	**3.3%**

not for spending on mathematical research per se, but are funds spent or estimated to be spent by the federal mathematical sciences programs on the various elements of the mathematical sciences enterprise.

National Science Foundation (NSF)

The NSF Division of Mathematical Sciences (DMS) fosters the creation and development of mathematical ideas and techniques, supports their interaction with theory and practice in other scientific and engineering disciplines, and encourages their diffusion into the infrastructure for education and human resource development and the technology base.

DMS provides almost half of all federal support for the mathematical sciences, covering the broadest range of mathematical fields with support for individual investigators and small groups, research institutes, shared computing equipment, postdoctoral fellowships, research conferences, and undergraduate programs.

The Division budget, which will grow in FY 1992 by 7.4 percent to $78.58 million, has been reorganized into three categories: disciplinary research in mathematics, cross-disciplinary and computational research in mathematics, and special projects. DMS has requested a budget of $84.95 million for FY 1993, a proposed increase of $6.37 million or 8.1 percent over FY 1992 spending. Funds for disciplinary research in FY 1993 would remain at the FY 1992 level, $48.23 million; support for cross-disciplinary and computational research would expand from $15.55 million to $20.48 million; and funds for special projects would increase by $1.44 million to $16.24 million.

This budget proposal reflects the priorities of the overall Foundation and federal R&D effort. More than three-quarters of the proposed DMS budget increase would be used to enhance the participation of the mathematical sciences in the FCCSET and NSF research initiatives--High Performance Computing and Communications, Advanced Materials and Processing, Biotechnology, Advanced Manufacturing, and Environmental Science. Researchers currently supported in disciplinary programs will be able to take advantage of the new opportunities in the cross-disciplinary and computational research category. The remainder of the increment would be used to expand support for postdoctoral fellowships and for undergraduate curriculum development.

Air Force Office of Scientific Research (AFOSR)

Funding for mathematical sciences research in support of the Air Force mission is provided by the Mathematical and Information Sciences Directorate of AFOSR. Projected spending for the mathematical sciences in FY 1992 and FY 1993 is expected to remain at the FY 1991 level of $17 million.

Army Research Office (ARO)

The Army Research Office plans a slight budget increase for the mathematical sciences program, from $13.5 million in FY 1992 to $14.0 million in FY 1993. Among other areas of interest, the program is focusing on mathematics of materials science, high performance computing, and mathematical and computational science in intelligent manufacturing. In FY 1993, the program will continue to fund the Mathematical Sciences Institute, the Center on Nonlinear Analysis and Mathematics of Materials Science, and the Army High Performance Computing Research Center. It will begin supporting the Center on Foundations of Intelligent Systems with FY 1992 University Research Initiative (URI) funds, but does not intend to establish any new centers in FY 1993.

Defense Advanced Research Projects Agency (DARPA)

The Applied and Computational Mathematics program at DARPA is undertaken to support the agency's advanced technology development mission. DARPA funds mathematical sciences research in four areas: modeling and simulation, algorithmic development, digital signal processing, and intelligent control. It should be noted that in this environment some of the research supported transcends the traditional boundary dividing the disciplines of mathematics on the one hand and computer science and engineering on the other.

In addition to core research activities, the program sponsors activities that contribute to the missions of several DOD-wide initiatives, which typically receive special appropriations from Congress. The University Research Initiative provides funds for multidisciplinary centers, and other sources provide support for graduate students and research at small businesses.

The DARPA program has grown rapidly over the past few years, and in fact, is the only DOD mathematical sciences program to experience any real growth in FY 1992. But the overall decline of the defense budget will take its toll next year. The proposed FY 1993 budget is $16.05 million, down from $18.67 million in FY 1992. Within the FY 1993 total, $11 million is allocated for core research, down from the current level of $12.32 million. URI funding would remain constant at $2.5 million.

National Security Agency (NSA)

The NSA Mathematical Sciences Program supports research in algebra, number theory, discrete mathematics, probability, statistics, and cryptology and awards grants in four categories: the Young Investigators Grant, the Standard Grant, the Senior Investigators Grant, and the Conferences and Special Situations Grant.

The NSA's was the first DOD mathematical sciences program to experience a declining budget: Spending peaked at $3.4 million in FY 1990 and will drop to at most $3 million in FY 1992. FY 1993 spending is estimated to continue at that level, although further cuts cannot be ruled out.

Office of Naval Research (ONR)

The Mathematical Sciences Division of the Office of Naval Research funds research in support of the naval mission, with designated programs in the areas of applied analysis, discrete mathematics, numerical analysis, operations research, probability and statistics, and signal analysis. It maintains a core program and also funds accelerated research initiatives (ARI's) as needed.

In FY 1992 the division plans to spend about $9.4 million on the core programs and about $4.7 million on ARI's. The FY 1993 budget includes $10 million in core program funding, and $5.5 million for ARI's. The total of $15.71 million includes a small amount of funds from a DOD-wide initiative to support young investigators.

Department of Energy (DOE)

The Applied Mathematical Sciences program in the DOE Office of Energy Research has two missions: to ensure the broad range of research in the mathematical and computer sciences necessary to underpin all the other sciences; and to manage an international network to provide state of the art supercomputing facilities for DOE-supported researchers. Its work is proceeding in the context of the multiagency High Performance Computing and Communications (HPCC) initiative, which encompasses R&D needed to produce the next generation of high performance computing hardware and software.

While the overall Applied Mathematical Sciences Program is experiencing strong growth because of its association with the HPCC initiative, spending increases are directed to software development activities. The program continues support for basic mathematical sciences, including research and related activities in analytical and numerical methods and information analysis techniques at universities and national laboratories. The budget for those activities will remain unchanged from FY 1992 to FY 1993 at $13.5 million.

Other Federal Agencies

Several agencies--for instance, the National Aeronautics and Space Administration, the National Institutes of Health, and the National Institute of Standards and Technology--support mathematical sciences research, largely as an intramural activity. These and other agencies, such as the Environmental Protection Agency and the Department of Transportation, supply a limited number of grants to academic mathematical scientists. The table shows a rough estimate of $1 million for extramural support from federal agencies without dedicated mathematical sciences programs.

Chapter 22

Computer Science and Engineering Support in the FY 1993 Budget

Computing Research Association

Fred Weingarten

Highlights

- The second year of the special High Performance Computing and Communications Initiative (HPCC) calls for an increase of 23 percent, up by $148 million to a requested level of $803 million for FY 1993.

- Of the four major HPCC program elements, Advanced Software Technology and Algorithms (ASTA) received the greatest increase. At a level of $346 million, ASTA is now well over one third of the total program budget.

- Funding for R&D on high-speed digital communications and implementing the Federal portion of the National Research and Education Network is scheduled to grow by 33 percent to $122 million.

- NSF and DARPA remain the biggest players in the initiative, with NSF receiving a the largest increase, 30 percent.

- Overall, computer science and engineering R&D funding at NSF increased at a higher rate than any other discipline. The Computer and Information Science and Engineering Directorate (CISE), received a 29 percent boost to $272 million.

- The NSF increase in CISE was due, in large part, to the impact of two special initiatives, HPCC and Advanced Manufacturing, which is also a computer intensive area of R&D, stressing such research fields as artificial intelligence, robotics, automated controls, and information management.

HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS (HPCC)

For a second year, the administration's budget requested a 23 percent increase in high performance computing and communications. Once again the program, identified as an "Interagency Presidential Initiative," was accompanied by its own special supplementary booklet, *Grand Challenges 1993. High Performance Computing and Communications.*

This initiative is distinguished in that it now has both executive and legislative authorization. After years of consideration and negotiation, the Congress passed last November and the President signed the High Performance Computing and Communications Act of 1991. The Act closely parallels the administration's initiative, not surprising since they evolved together along very similar tracks. However, in the interests of passage, the Act did back away from resolving some thorny problems, particularly with respect to the National Network, that threaten to become contentious this year.

Last year, Congress appropriated $654.8 million for the HPCC program (actually $16.5 million over the administration's original FY 1991 request, an amount that mainly reflects an increased level of effort on the part of some of the smaller participants such as NOAA and NIH). This year's request was for $802.5 million. Table 1 shows how the requested funds will be distributed among the eight participating agencies. NSF's $61 million increase was the largest, not only in dollars, but by percentage increase (30 percent for NSF compared with 18 percent for DARPA, 18 percent for Energy, and 25 percent for NASA.)

The Initiative consists of four basic program elements:

- HPCS (High Performance Computing Systems): To accelerate the development of future generation high performance computer systems. The main emphasis in this program is on massively parallel computer architectures.

- ASTA (Advanced Software Technology and Algorithms): To develop software tools for using high performance computers, particularly in "Grand Challenge" research areas. This program element also includes support for national supercomputer centers to serve as resources for users in all research disciplines, from both academic and industrial laboratories.

- NREN (National Research and Education Network): To develop and support high speed data communications networks to serve research and education. In particular, support of the NSFNET backbone is included as well as basic and applied research on extremely high speed data communications technology.

- BRHR (Basic Research and Human Resources): To support the underlying needs for basic research and education required for the program. Basically, recognizing that the first three goals cannot be achieved as development efforts without a concomitant long–term program of more fundamental research and education, this element specifically lays out funding for that purpose.

Eight agencies are participating in the initiative at this time. Four—NSF, DARPA, NASA, and Energy—have lead roles in developing new science and technology. These four agencies, of course, have a long tradition of supporting R&D in information technology. The other four agencies—EPA, NOAA, NIH, and NIST—are primarily concerned as users of high performance computing in their own R&D efforts. They provide a base of demanding applications for the new technology.

Table 1 shows how funds are being allocated for these four components among the eight participating agencies. Table 2 indicates roughly how program emphasis is changing between last years request and this year. (Breakdowns of actual expenditure for last year among the program elements are not available, so this table is only an estimate.) Clearly, NREN and ASTA are in for more emphasis. In fact, since 1991 NSF expenditures for NREN were down several million due to cuts in NSF appropriations, the 1992 requested increment is even greater in percentage terms.

Similarly, the ASTA software component is receiving greater attention from all agencies, including "user" agencies such as the National Oceanographic and Atmospheric Administration (NOAA), the National Institutes of Health/Library of Medicine (NIH/NLM), and the Environmental Protection Agency (EPA). This emphasis, on applications and infrastructure-building reflects a general consensus among policy makers that the program, in order to justify these growing expenditures, must have a major impact on users—making new high performance systems more accessible and usable, and solving serious problems with them

On the other hand, these numbers also illustrate that the HPCC Initiative should not be seen as solely a program of support for the computing research community. Funding requests for basic research and human resource are up by 25 percent, to be sure, but that is only one fifth of the total program.

The origins of the program are a call in the early 1980's for better computational tools to provide broad support for research in science and engineering. The increasing emphasis on applications programs (through ASTA) and for infrastructure-building (support of national supercomputer centers and NREN), suggests that the principal beneficiaries of this work will be outside the computing disciplines. In fact, the chief importance of the HPCC initiative for computer science and engineering may be that it will establish much closer connections between computing researchers and the academic and industrial user community that is bringing increasingly sophisticated and intellectually challenging problems to the table.

Even with broad support and a large requested increase for this year, all is not sanguine on the HPCC. Debate is heating up on some aspects of the Initiative, itself, with questions being raised both by industrial and academic supporters.

Some are asking whether the HPCS program is being coordinated and run in such a way as to maximize the technology flow from Federally funded research projects to the computer and software industries. They also argue that the Federal agencies have too eager to make judgments about future winners and losers in computer architecture and are directing the research money too narrowly.

More importantly, a debate has opened on the future of the NREN. Although it has many facets, this issue boils down to two questions.

Management: Is the current NREN program being coordinated well enough, both among the Federal agencies charged with developing it, and between government and the academic and industrial users of NREN. What is the long term Federal management structure for NREN? Is the outside community—both users and other network operators—being given adequate input to decisions on technology and operating policies? (The NREN is a conglomerate of private, local public and federally funded networks. The Federal portion, although critical as the network "backbone" represents a proportionally small share of the cost.)

Role of the Private Sector: What is the proper relationship between a federally subsidized NREN and private sector providers? What are the plans, if any, for privatizing and commercializing NREN services, and how will the private carriers be involved with NREN development?

In a sense, these questions all arise from the success of the HPCC and the Federal Internet. No one fights over losers. They also stem from a general belief among some technologists and policy makers that the future of the nation lies in the rapid deployment of a modern digital information infrastructure. The NREN is somehow incorporated into this larger vision, as technology testbed, prototype, or some form of precursor to this universal network. Thus, what started as simply a support infrastructure for basic research is now being asked to bear a much greater burden of expectations. These expectations may well lead to greater support and funding, but they may also stress network politics to the point where its scientific benefits suffer.

National Science Foundation

Proportionally, the Computer and Information Science and Engineering Directorate was projected to grow by 29%, the largest (in percentage terms) of all research Directorates. Breakdowns among divisions in CISE are shown in Table 3. Care must be taken in drawing too many conclusions from the fine structure of these budgets. As a young field, the intellectual structure of computer science and engineering changes particularly rapidly. Program elements and subfields are often moved around among divisions in response to the changes in the field and to keep administrative balance within NSF. However, some meaningful detail can be discerned.

CISE has two related but distinct missions—to support basic computing research and to support the development of the infrastructure and intellectual foundations of computational science. The ACS Division, for example, will spend approximately $66 million to partial support of four national supercomputer centers, which are available to a broad academic and industrial research community. The NCRI Division will devote $37 million to support of NSFNET, the NSF-funded portion of the interim National Research and Education Network called for in the HPCC Initiative and Act. At the same time, the research divisions are also projected for a healthy growth, as the table shows.

CISE appears to be benefiting particularly well from the special initiatives. CISE officials report that $59 million dollars of the $61 million increase is due to special initiatives, particularly HPCC and Advanced Manufacturing. Since a little less than half of that increase is directed to the infrastructure divisions mentioned above, the rest will go to support of research.

The impact of HPCC and the Advanced Manufacturing initiatives can be seen in the proportionally large increases given to Microelectronics Information Processing Systems (MIPS) and Information, Robotics, and Intelligent Systems (IRIS) divisions, which led the more theoretical Computer and Computational Research (CCR) division in absolute increment and proportionally.

Other

Because, like applied mathematics, computation is becoming a basic tool in all research disciplines, many other agency research programs, from **NIH** to **NASA** have implications for computing research, yet are hard to tease out of initial budgets requests. Support for computing research can be buried in agencies' mission budgets. Conversely, much that has a computation label in the budgets is simply support and application system development, with little relevance to the research community.

One of the interesting side benefits of the HPCC initiative is that it has pulled some numbers out of these user agencies. The line items for the agency input to HPCC may not be complete, but it serves as a first approximation to those agencies' contributions that we have had prior to last year. One minor factor contributing to the size of the HPCC budget no doubt has simply been more thorough agency reporting and relabeling of on-going activities.

Table 1: High Performance Computing and Communications 1993 Proposed Agency Funding (in $Millions)

Agency	FY 1991	FY 1992	FY 1993	FY 1993 by Program			
	Actual	Estimate	Request	HPCS	ASTA	NREN	BRHR
DARPA	183.0	232.2	275.0	119.5	49.7	43.6	62.2
NSF	169.0	200.9	261.9	28.6	125.6	45.1	62.6
DoE	65.0	92.3	109.1	10.9	69.2	14.0	15.0
NASA	54.0	71.2	89.1	14.1	61.4	9.8	3.8
NIH	13.5	41.3	44.9	4.2	22.6	7.2	10.9
DoC/NOAA	1.4	9.8	10.8	0.0	10.4	0.4	0.0
EPA	1.4	5.0	8.0	0.0	6.1	0.4	1.5
NIST	2.1	2.1	4.1	1.1	1.0	2.0	0.0
Total	489.4	654.8	802.9	178.4	346.0	122.5	156.0

Table 2: Selected Agency Comparisons of HPCC Program Requests for 1992 and 1991 (Amounts in Millions)

	HPCS	ASTA	NREN	BRHR
NSF 1992 Request	24.0	103	32.7	53.3
NSF 1993 Request	28.6	125.6	45.1	62.6
NSF Delta	4.6	22.6	12.4	9.3
% Delta	19	22	38	17
DARPA 1992 Request	103.3	38.5	32.9	57.5
DARPA 1993 Request	119.5	49.7	43.6	62.2
DARPA Delta	16.2	11.2	10.7	4.7
% Delta	16	29	33	8
Overall FY 1992 Request	156.8	265.1	91.9	124.5
Overall FY 1993 Request	178.4	346.0	122.5	156.0
Overall Delta	21.6	80.9	30.6	31.5
% Delta	13.8	30.5	33.3	25.3

Legend:

HPCS:	High Performance Computing Systems
ASTA:	Advanced Software Technology and Algorithms
NREN:	National Research and Education Network
BRHR:	Basic Research and Human Resources

TABLE 3: NSF CISE Funding Allocation Among Programs (in Millions of Dollars)

CISE Division	FY 91 Actual	FY 92 Request	FY 92 Current Plan	FY 93 Request	Delta	% Delta
CCR	31.32	37.93	34.84	43.04	8.20	23.5
IRIS	23.59	29.21	26.98	36.83	9.85	36.3
MIPS	18.53	23.50	21.51	30.44	8.93	41.5
ASC	66.51	72.10	69.61	86.71	17.10	24.6
NCRI	29.80	42.24	35.49	48.09	12.60	35.5
CDA	19.76	24.52	22.51	27.11	4.60	20.4
Total	189.51	229.50	210.94	272.22	61.28	29.1

Legend:

CISE: Computer and Information Science and Technology Directorate
CCR: Computer and Computation Research Division
IRIS: Information, Robotics, and Intelligent Systems Division
MIPS: Microelectronic Information Processing Systems Division
ASC: Advanced Scientific Computing Division
NCRI: Networking and Communications Research and Infrastructure Division
CDA: Office of Cross-Disciplinary Activities

Chapter 23

Electrotechnology-Related Research in the FY 1993 Budget

Institute of Electrical and Electronics Engineers

Chris J. Brantley

HIGHLIGHTS

- $803 million (a 23 percent increase) for multi-agency efforts on High Performance Computing and Communications
- $1.8 billion for Advanced Materials and Processing R&D - Electronics ($176.6 million), Optical/Photonics ($138.8 million), and Superconducting ($142.9 million) materials
- $1.37 billion (a 24 percent increase) for the U.S. Global Change Research Program including $390 million for NASA's Earth Observing System and EOS Data Information System
- $1.1 billion (a 27 percent increase) for non-defense related Manufacturing R&D including automation and control, information management, artificial intelligence, and flexible computer integrated manufacturing
- $68 million for the NIST Advanced Technology Program, which awarded 9 of its first 11 grants to electronics firms

INTRODUCTION

As these highlights illustrate, investments in electrical and electronics technologies (i.e., "electrotechnology") are an important focus of the Bush Administration's strategy of enhancing federal support for research and development. This report provides an overview of proposed R&D funding levels at key agencies and highlights those electrotechnologies which are significantly affected by the Administration's budget proposal. It is not intended to be all inclusive as time and space limitations preclude reporting on all electrotechnology-related programs funded by the $76 billion in federal R&D budget authority requested for FY 1993.

This analysis has been prepared primarily on the basis of budget figures provided by the federal departments and agencies on or after release of the President's budget on January 28, 1992. All figures are in current dollars so that requested increases (or decreases) do not reflect the impact of inflation.

DEPARTMENT OF DEFENSE

The Department of Defense (DoD) budget request for Research, Development, Test, and Evaluation (RDT&E) is slated to increase a modest 1.2 percent to $38.8 billion in FY 1993. The DoD's RDT&E budget and other defense-related research performed by other agencies comprises approximately 60 percent of the total federal R&D budget request — only a slight drop from FY 1992.

The Research and Development component of the RDT&E budget would decrease 1.3 percent to $27.4 billion. Funding for Technology Base (i.e., basic and exploratory research) programs increases 4.35 percent to $4.08 billion. Broken down by research categories, the budget requests a 9.7 percent increase for Research ($1.12 billion), a 3.2 percent increase for Exploratory Development ($2.99 billion), and a 6.9 percent increase for Advanced Development ($11.4 billion). Engineering Development drops 12.7 percent to $8.99 billion, and Management and Support holds steady at $2.9 billion.

Allocation of these funds varies through the Tri-services and Defense Agencies. Below is a brief overview with highlights of technology base and advanced technology development programs of particular relevance to electrical and electronics engineering:

Army RDT&E — Total funds allocated for Army RDT&E would decrease 16 percent to $5.4 billion in FY 1993. The R&D component drops 16.5 percent to $5.02 billion. Technology Base funding also decreases 11.8 percent to $753.3 million. Among programs of interest:

• Defense Research Sciences	- 6.8 %	$166.6M
• Electromechanics	+ 31.4 %	$ 3.9M
• Electronic Survivability and Fuzing Technology	- 4.3 %	$ 19.2M
• Electronics/Elect. Devices	- 9.9 %	$ 18.0M
• Command, Control & Communications (C^3)	+ 26.0 %	$ 23.3M
• Computer & Software Tech.	- 45.7 %	$ 3.1M
• Artificial Intelligence	+ 12.9 %	$ 3.3M

Advanced Technology Development would increase 4.8 percent to $431.7 million. Among programs of interest:

• C^3 Advanced Technology	+ 20.9 %	$ 38.5M
• Global Surveillance/Air Defense Tech. Demons.	(New)	$ 50.0M
• Electronic Warfare Tech.	+ 25.5 %	$ 8.9M
• Advanced Electronic Devices Development	+ 65.0 %	$ 6.6M
• Advanced Tactical Computer Science and Technology	+160.2 %	$ 22.4M

Navy RDT&E — The Navy's RDT&E budget decreases by less than half a percent to $8.52 billion in FY 1993. The R&D component drops 10.6 percent to $5.95 billion. Technology Base funding jumps 21.9 percent to $1.096 billion including increases for:

• Defense Research Sciences	+ 20.0 %	$457.4M
• C^3 Technology	+ 51.7 %	$ 22.6M
• Electronic Warfare Tech.	+ 32.8 %	$ 18.5M
• Undersea Surveillance Tech.	+ 12.4 %	$146.2M
• Ocean & Atmospheric Support Technology	+ 11.2 %	$ 49.6M

Advanced Technology Development increases 96 percent to \$418.5 million, with several programs showing significant changes:

Air Systems Adv. Tech. Dev.	+124.7 %	\$ 20.1M
Global Surveillance/Air Defense Tech. Demons.	(New)	\$ 50.0M
Advanced EW Technology	+529.6 %	\$ 30.8M
Advanced Tech. Transition	+ 36.3 %	\$ 84.7M
C^3 Advanced Technology	+ 54.6 %	\$ 2.1M

Air Force RDT&E — Air Force RDT&E would increase by 6.9 percent in FY 1993 to \$14.53 billion. The R&D component grows 6.3 percent to \$8.04 billion. Technology Base funding would grow by 24.4 percent to \$1.02 billion with increases for:

Defense Research Sciences	+ 15.0 %	\$237.4M
Aerospace Avionics	+ 31.4 %	\$105.5M
Rocket Propulsion and Astronautics Tech.	+ 28.1 %	\$ 42.2M
C^3	+ 41.2 %	\$115.3M

Advanced Technology Development would increase by 12.5 percent to \$818.1 million. Among programs of interest:

Adv. Avionics/Aero. Vehicles	+ 51.8 %	\$ 51.6M
Global Surveillance/Air Defense Tech. Demons.	(New)	\$ 25.0M
Adv. Avionics Integration.	+ 49.3 %	\$ 24.7M
Nat'l Aero-Space Plane	- 12.3 %	\$175.5M
EW Technology	+ 0.4 %	\$ 32.8M
C^3I Subsystem Integration	+ 41.8 %	\$ 13.5M
Advanced Computer Tech.	+ 13.0 %	\$ 11.1M
C^3 Advanced Development	+ 1.8 %	\$ 9.8M

RDT&E in the Defense Agencies — RDT&E across the Defense Agencies would increase by 5.6 percent to \$10.05 billion. The R&D component grows 10.7 percent to \$8.07 billion with increases for Advanced Development (up 15.4 percent to \$6.5

billion) and Engineering Development (up 34.4 percent to $237.6 million).

The Strategic Defense Initiative Organization (SDIO) remains the federal government's largest single R&D initiative, with a proposed increase of 29 percent to $5.3 billion in FY 1993. SDIO program lines include:

Space Based Interceptors	+ 23.5 %	$ 575.6M
Limited Defense System	+ 48.8 %	$2134.8M
Theater Missile Defenses	+ 6.9 %	$ 857.7M
Other Follow-up Systems	+ 27.5 %	$ 849.6M
Research & Support Activ.	+ 5.6 %	$ 754.7M

The Defense Advanced Research Projects Agency (DARPA) would suffer a 12.2 percent decrease to $1.29 billion. DARPA Technology Base programs decline by 12.2 percent to $684.3 million. Among programs affected:

Defense Research Sciences	+ 12.2 %	$126.1M
Strategic Technology	+ 26.8 %	$377.1M
Tactical Technology	- 12.4 %	$109.3M
Materials and Electronics Technology	- 36.2 %	$ 71.8M

Advanced Technology Development within DARPA is also down by 11.7 percent to $584.2 million. Increases go to Experimental Evaluation of Major Innovative Technology (up 8.5 percent to $270.9 million) and Manufacturing Technology/ SEMATECH (up 22.5 percent to $255.4 million). Programs dropped include: Pre-Competitive Technology Development ($60 million in FY 1992), Prototyping of Advanced Technologies and Innovative Concepts, and the Consolidated DoD Software Initiative.

DEPARTMENT OF ENERGY

Total FY 1993 budget authority for the Department of Energy (DOE) would increase 2 percent to $19.4 billion. DOE's defense-related programs rise 1.2 percent to $12.12 billion in the FY 1993 budget request, still slightly over 62 percent of the Department's total budget. Approximately $6.58 billion of the DOE budget is allocated to research and development (an increase of 1 percent).

DOE's request for Energy Supply R&D grows 7.6 percent to $3.19 billion with principal increases targeted for environmental restoration and waste management. Solar and Renewable Energy R&D is up 1.6 percent to $206.9 million including increases of 5 percent for photovoltaics ($63.5 million), 100 percent for solar technology transfer ($2 million), 23 percent for biofuels ($48.35 million), and 2.8 percent for wind energy systems ($22 million). Programs cut include solar thermal (down 7.2 percent to $27 million), ocean energy systems (eliminated), and geothermal (down 10 percent to $24.4 million).

A total of $40.1 million is requested for Electric Energy and Storage Systems — an increase of 5.5 percent. Major funding goes to research on High Temperature Superconductivity ($22.5 million) and research on the potential health effects of exposure to electric and magnetic fields ($7.5 million).

Funding for Nuclear R&D activities drops 6.7 percent to $309.6 million. Support for development and certification of standardized, passively safe light water reactors is down 6 percent to $58.7 million. Advanced Reactor R&D on Advanced Liquid Metal Reactor and Modular High Temperature Gas Reactor concepts is also down by 16 percent to $50 million. Forty million dollars is provided for space-related nuclear power research.

DOE's support for Fusion R&D grows 8.9 percent to $359.7 million. The magnetic fusion program will support U.S. participation in the International Thermonuclear Experimental Reactor (ITER), deuterium-tritium fuel experiments at Princeton University's Tokamak Fusion Test Reactor, and planning for a future experimental facility to replace the cancelled Burning Plasma Experiment. Inertial Confinement Fusion research remains flat at $8.15 million.

Also within the Energy Supply R&D appropriation, funding for individual investigator grants for research on Basic Energy Sciences grows 6.4 percent to $813.9 million; University and Science Education Programs edge up 2 percent to $55.7 million; and DOE's Laboratory Technology Transfer Initiative grows 52 percent to $15.1 million.

DOE's request for Fossil Energy R&D drops nearly 30 percent to $311.3 million. The only programs to enjoy increases are Unconventional Gas Recovery (up 218 percent to $40 million), Surface Coal Gasification (up 30.5 percent to $14.5 million), Enhanced Oil Recovery (up 26 percent to $46.5 million), and Fossil Energy Environmental Restoration (up 18 percent to $12.5 million). Clean Coal Technology funding grows by 20.5 percent to $500 million to support ten additional demonstration projects currently undergoing negotiations.

Energy Conservation programs are supported by an adjusted FY 1993 budget request of $491.4 million, a decrease of 2.9 percent, which reflects an annual attempt to cut Technical and Financial Assistance Programs (down 30 percent to $191.7 million). Increases are slated for conservation programs in the Utility (up 26.6 percent to $6 million), Buildings (up 10.7 percent to $52.5 million), Industry (up 7.9 percent to $105.2 million), and Transportation (up 46 percent to $162.4 million) sectors. In the Transportation sector, DOE will continue its support for the U.S. Advanced Battery Consortium to promote electric vehicles (up 56 percent to $41.4 million) as well as seeding $20 million for a new government-industry consortia to develop hybrid vehicle propulsion technologies.

DOE's General Science and Research budget increases 12.2 percent to $1.65 billion including $630.9 million for High Energy Physics (up 0.5 percent); $650 million for the Superconducting Supercollider (up 34.4 percent), and $363.5 million for Nuclear Physics (up 2.6 percent). Finally, DOE has requested $114.3 million for math, science, and engineering education programs, an increase of 2 percent over FY 1992.

DEPARTMENT OF TRANSPORTATION

The FY 1993 budget proposes $498 million, an increase of 12 percent, for research and development programs of the Department of Transportation. Of particular note are investments of $138 million for Intelligent Vehicle Highway Systems (of which $100 million is designated for demonstration projects) and $15 million for R&D of High-Speed Rail and Magnetic Levitation (Maglev) technologies.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Administration proposes a FY 1993 budget of $14.9 billion for the National Aeronautics and Space Administration (NASA), an increase of 4.5 percent within the guidelines set by Congress in the FY 1992 NASA appropriation. NASA funding for research and development would grow 12.9 percent to $7.73 billion.

Described by outgoing NASA Administrator Admiral Richard Truly as "the cornerstone of America's future space program," Space Station Freedom is slated for a 10.9 increase to $2.25 billion in FY 1993. With first element launch scheduled for early 1996, Freedom must pass its final design review in FY 1993.

A total of $863.7 million, an increase of 20 percent, is requested for Space Transportation Capability Development, including $122.6 million for Spacelab (up 23.6 percent), $153.6 million for payload operations and support equipment (up 29 percent), and $125 million for a new National Launch System (up 346.4 percent).

The budget for core Space Science programs (i.e., physics and astronomy, life sciences, and planetary exploration) edges up 3 percent to $1.78 billion and proposes termination of the Comet Rendezvous/Asteroid Flyby (CRAF) mission and the Shuttle Test of Relativity Experiment (STORE). Earth Science and Applications programs support NASA's "Mission to Planet Earth" and agency participation in the President's Initiative on Global Climate Change

Research. A restructured Earth Observing System would receive $308.4 million, an increase of 63.7 percent, while the EOS Data Information System (EOSDIS) is flat at $82.6 million. Funding for Earth Probes drops 4 percent to $88.9 million; the Ocean Topography Experiment is zeroed; and $142.1 million is requested for overall mission operations and data analysis — an increase of 60 percent.

Within Space Applications, funding for Space Communications drops 63.2 percent to $4.6 million with launch of the Advanced Communications Technology Satellite (ACTS), and $25 million is allocated for NASA collaboration with DoD on a Landsat 7 remote sensing program.

Commercial Space Programs grow 16.3 percent to $171.6 million with an increase of 21.5 percent for NASA's Centers for the Commercial Use of Space (to $139.9 million).

Funding for Aeronautics Research and Technology would increase by 13.5 percent to $890.2 million, including $35 million for high performance computing and $80 million for accelerated development of the joint NASA/DoD National Aero-Space Plane.

Space Research and Technology would increase by 5.6 percent to $332 million, and includes 173.8 million for technology base research (up 10 percent), $158.2 million for the Civil Space Technology Initiative (up 4.5 percent), $31.8 million for Space Exploration (up 536 percent), $80 million for Transatmospheric Research and Technology (up 1500 percent), and $71.4 million to support NASA's academic programs (up 6.9 percent).

Among other NASA programs, the request for Space Flight, Control & Data Communications drops 2 percent to $5.27 billion, reflecting a controversial decision to cancel the shuttle's Advanced Solid Rocket Motor program, barring provision of additional appropriations by Congress.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

The Administration has requested a FY 1993 budget appropriation of $310.7 million for the National Institute of Standards and Technology (NIST), a 26 percent increase consistent with the President's goal of doubling the NIST appropriation by FY 1996. NIST also projects $214 million in revenue from contract research and fees paid by other agencies for a total resources budget of $525 million.

NIST's intramural standards and measurements programs would grow 16 percent to $201.9 million, including increases for electronics and electrical engineering (up 15.9 percent to $29.3 million), manufacturing engineering (up 36.9 percent to $13 million), computer systems (up 47.6 percent to $17.6 million), and advanced materials (up 11.4 percent to $38.6 million).

Funding for NIST's extramural programs would grow 28.8 percent to $86 million. The Advanced Technology Program increases 36 percent to $67.9 million to fund 5-10 new grants for pre-competitive technology research. The budget provides $17.8 million, a 13.4 percent increase, for seven regional Manufacturing Technology Centers. The State Technology Extension Program would be cut back 70 percent to $383,000 in FY 1993 and eliminated in FY 1994.

NATIONAL SCIENCE FOUNDATION

To meet the President's goal of doubling the National Science Foundation (NSF) budget by 1994, the Administration has requested an FY 1993 NSF budget of $3.05 billion, an increase of 17.6 percent. Funding for NSF's research and related programs would increase by 18 percent to $2.21 billion. Major focuses include support for Presidential Initiatives on Advanced Materials and Processing ($104.5 million), Biotechnology ($205.6 million), High Performance Computing and Communications ($262 million), and U.S. Global Change Research ($162.5 million), as well as increased support for advanced manufacturing ($104.5 million) and multidisciplinary environmental research ($118 million).

NSF's Computer and Information Science and Engineering (CISE) Directorate jumps 29 percent to $272.2 million. Of this total, $229 million is directed toward High Performance Computing and Communications including $48.1 million, a 35 percent increase, for research on the proposed National Research and Education Network.

The Engineering Directorate grows 21 percent to $312.5 million with new monies directed toward initiatives in Advanced Materials and Processing ($18.4 million), High Performance Computing and Communications ($3.1 million), Biotechnology ($5.2 million), advanced manufacturing technologies ($13.2 million), and Small Business Innovative Research ($4.8 million). Total funding for Electrical and Communications Systems research is up 25 percent. Funding for the Engineering Research Centers grows 12 percent to $53.2 million to support new centers for research on advanced intelligent manufacturing and materials synthesis and processing.

Chapter 24

Chemical Engineering in the FY 1993 Budget

American Institute of Chemical Engineers

J.R. Hightower, Betsy Houston

Highlights

Chemical engineering will again be supported by large, federal programs in FY 1993, and these programs will increase over FY 1992 levels for FY 1993. Data were obtained this year for the Department of Energy (DOE), National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the Nuclear Regulatory Commission (NRC). As indicated by the summary in Table 1, these data indicate that spending on programs supporting chemical engineers would increase by 10.1 percent from $10.0 billion to $11.0 billion in FY 1993. As in the past, the totals are dominated by the DOE programs. A new interagency program, the Advanced Materials and Processing Program (AMPP), to improve the manufacture and performance of materials has been initiated this year. This new program increases the federal government's total support of materials R&D from $1.401 billion in FY 1992 to $1.531 billion in FY 1993 (an increase of 9.3 percent) and will be a significant benefit to chemical engineers. The three agencies with the largest contributions to this initiative are (in order of size of contributions): Department of Energy, Department of Defense, and National Science Foundation.

TABLE 1. SUMMARY OF FEDERAL SUPPORT FOR CHEMICAL ENGINEERING
($ in millions)

Agency	FY 1992	FY 1993	Percent change
Department of Energy	9,317.932	10,271.458	10.2
National Science Foundation	234.170	271.470	15.9
Environmental Protection Agency	333.762	344.810	3.3
Nuclear Regulatory Commission	121.932	131.150	7.6
TOTAL - Chemical Engineering Support	10,007.796	11,018.888	10.1

Department of Energy

Funding for programs important to chemical engineers in DOE is shown in Table 2. Overall, the programs increase 10.2 percent from $9.32 billion in FY 1992 to $10.27 billion in FY 1993. Environmental restoration and waste management is the fastest growing program area in the DOE (shown in Table 2 separated into defense-related and nondefense-related programs). These combined programs increase 26 percent from a total of $4.28 billion to a total of $5.32 billion. This, along with the environmental restoration activities in uranium enrichment, accounts for fully one-fourth of the budget for the DOE. Other significant increases include: Biofuels Energy Systems (up 23 percent), a new program on Space Exploration Initiative, Basic Energy Sciences (reflecting an enhancement for materials research as part of the U.S. Advanced Materials and Processing Program), Clean Coal Technology, a restructured natural gas program, and increased energy efficiency in the industrial sector. Total DOE support of the AMPP from all program areas is $423.8 million. Significant decreases come in the materials production program as a result of the decreased nuclear threat and in coal research and development.

TABLE 2. DEPARTMENT OF ENERGY

($ in millions)

	FY 1992	FY 1993	Percent Change
ENERGY R&D			
Solar Energy			
- Solar Thermal Energy Systems	29.100	27.000	-7.2
- Biofuels Energy Systems	39.300	48.350	23.0
- Ocean Energy Systems	2.000	0.000	-100.0
Energy Storage Systems	7.246	6.300	-13.1
Nuclear R&D Activities			
- Fuel Cycle R&D	32.039	32.539	1.6
- Space Exploration Initiative	5.000	10.000	100.0
- Advanced Radioisotope Power	51.000	51.840	1.6
Civilian Waste R&D	4.700	0.700	-85.1
Environment, Safety, & Health	159.670	166.670	4.4
Basic Energy Sciences	764.700	813.900	6.4
- Materials Sciences			
- Chemical Sciences			
- Engineering and Geosciences			
Environmental Restoration & Waste Management	602.495	706.974	17.3
URANIUM ENRICHMENT			
Uranium Enrichment Activities	1,201.495	1,164.613	-3.1
DEFENSE ENVIRONMENTAL RESTORATION & WASTE MANAGEMENT	3,680.672	4,609.729	25.2
MATERIALS PRODUCTION	1,876.900	1,776.725	-5.3
FOSSIL ENERGY R&D			
- Coal	279.317	153.900	-44.9
- Gas	12.571	40.000	218.2
- Petroleum	57.256	57.000	-0.4
CLEAN COAL TECHNOLOGY	415.000	500.000	20.5
CONVERSATION			
- Industry	97.471	105.218	7.9
TOTAL DOE	9,317.932	10,271.458	10.2

National Science Foundation

Budgets for programs in the NSF that support chemical engineers are shown in Table 3. Overall, spending for these programs are expected to increase by 15.9 percent, with all areas showing an increase. The Engineering request provides for participation in several interagency and NSF-wide initiatives in vital technology areas, with emphasis on the support of individual investigators and graduate students. These funding increases specifically include $18.4 million for the U.S. Advanced Materials Processing Program. Engineering centers will receive increased funding to bolster support for existing centers and to establish centers focused on advanced intelligent manufacturing and materials synthesis and processing. The Mathematical and Physical Sciences requests includes a total commitment to the U.S. Advanced Materials Processing Program of $187.6 million out of the total activity request of $726.0 million.

TABLE 3. NATIONAL SCIENCE FOUNDATION
($ in millions)

	FY 1992	FY 1993	Percent Change
ENGINEERING			
Chemical and Thermal Systems			
- Chemical Reaction Processes	8.360	10.880	30.1
- Interfacial, Transport, and Separation Processes	9.400	11.400	21.3
- Fluid, Particulate, and Hydraulic Systems	10.150	11.390	12.2
- Thermal Systems	8.450	9.890	17.0
Engineering Education and Centers			
- Engineering Research Centers	47.520	53.220	12.0
- Industry/University Cooperative Research Centers	6.700	7.200	7.5
MATHEMATICAL AND PHYSICAL SCIENCES			
Materials Research	143.590	167.490	16.6
TOTAL NSF	234.170	271.470	15.0

Environmental Protection Agency

Total support for programs important to chemical engineers in the EPA is expected to increase slightly (up 3.3 percent to $344.8 million) as shown in Table 4. The 1993 research and development program was developed around six themes: (1) improving the EPA's knowledge base, (2) implementing new legislation, (3) geographic and ecological initiatives, (4) clusters, (5) international support, and (6) facility and management.

Air quality research increases in support of implementation of the new Clean Air Act, the U.S. Global Change Research Program, and increased indoor air quality research. Drinking water research will be refocused on understanding the mechanisms of groundwater contamination from uses of agricultural pesticides and fertilizers. Hazardous waste research will be refocused on determining safe and effective means of disposing and controlling hazardous wastes. Increases in pesticides research will be directed to addressing neurotoxicological health concerns from exposure to pesticides. Toxic substances research will continue to focus on reducing risks to exposure to human health and the environment from exposure to toxic chemicals. The Superfund research program will continue to provide technical assistance and scientific information necessary to clean up Superfund sites.

TABLE 4. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH AND DEVELOPMENT PROGRAMS
($ in millions)

	FY 1992	FY 1993	Percent Change
RESEARCH MEDIA PROGRAM			
Air	126.763	136.438	7.6
Water Quality	30.598	32.651	6.7
Drinking Water	22.059	21.859	-0.9
Hazardous Waste	47.746	42.373	-11.3
Pesticides	14.488	15.766	8.8
Toxic Substances	25.336	26.817	5.8
Superfund	66.772	68.906	3.2
TOTAL EPA	333.762	344.810	3.3

Nuclear Regulatory Commission

NRC programs of interest to chemical engineers are primarily under the program elements Nuclear Safety Research, Nuclear Material and Low-Level Waste Safety and Safeguards Regulation, and High-Level Nuclear Waste Regulation. The subelements of specific interest are listed in Table 5, although budget assignments for these lower program elements were not available. As seen in Table 5, these programs increase 7.6 percent overall.

TABLE 5. NUCLEAR REGULATORY COMMISSION
($ in millions)

	FY 1992	FY 1993	Percent Change
NUCLEAR SAFETY RESEARCH			
Reactor Licensing Support	36.474	45.393	24.5
- Standard Reactor Designs			
- Reactor Aging and License Renewal			
Reactor Regulation Support	50.034	47.542	-5.0
- Plant Performance			
- Reactor Accident Analysis			
Nuclear Materials Licensing and Regulation Support	9.472	9.715	2.6
- Nuclear Materials			
- Low-Level Waste Disposal			
NUCLEAR MATERIAL AND LOW-LEVEL WASTE SAFETY AND SAFEGUARDS REGULATION			
Nuclear Material Safety	4.650	4.900	5.4
- Fuel Facility and Spent Fuel Storage Licensing and Inspection			
- Licensing and Inspection of Nuclear Material Users			
- Event Evaluation			
Low-Level Waste	2.550	2.500	-2.0
- Low-Level Waste Disposal Licensing and Inspection			
- Uranium Recovery Licensing and Inspection			
- Decommissioning			
HIGH-LEVEL NUCLEAR WASTE REGULATION	18.752	21.100	12.5
TOTAL NRC	121.932	131.150	7.6

Chapter 25

R&D in Materials Science and Engineering

Federation of Materials Societies

Betsy Houston

OVERVIEW

Over the last several years, the need to strengthen the federal commitment to materials research and development has become increasingly recognized. Last year, the National Critical Technologies Panel identified materials technology as one of six broad areas of needs, and materials figure prominently in federal agencies' lists of important technologies. As we have reported over the years, however, it has been difficult to identify some pockets of materials R&D within various agencies.

In FY 1993, however, a multi-year, multi-agency program will be initiated, called the Advanced Materials and Processing Program (AMPP), developed under the auspices of the Federal Coordinating Council on Science, Engineering and Technology. The Federation of Materials Societies has not analyzed in depth the figures proposed in the budget, but offers the following as a summary of the AMPP.

The AMPP has four strategic objectives:

- Establish and maintain the U.S. scientific and technological leadership position in advanced materials and processing;
- Bridge the gap between innovation and application of advanced materials technologies;

- Support agencies' mission objectives to meet national needs with improvements in advanced materials and processing; and
- Encourage university and private sector R&D activities in materials technologies, their applications, and their implementation.

Its announced bottom line:

- An increase in the FY 1993 budget request aggregated over 10 agencies to $1.821 billion, an increase of 10 percent over the FY 1992 base. This total includes $1.531 billion for direct programs, an increase of $129.5 million, and $290.5 million for construction and operation of the National User Facilities.

The AMPP lists 38 "program enhancements" grouped into four areas of materials R&D. Highlights include:

Synthesis and Processing

- development of the fundamental understanding required for process control of advanced ceramic structures via hot-isostatic-pressing and microwave sintering (Department of Energy);
- extension of university-based programs emphasizing synthesis and processing (National Science Foundation);
- expansion of applications for "intelligent" processing of materials, through the formation of multidisciplinary and multifactional teams of university researchers, systems developers, vendors, equipment manufacturers, and end users, with an initial focus on advanced control of injection molding of polymers (Department of Energy).

Theory, Modeling, and Simulation

- expansion of individual investigator efforts in theory, modeling, and simulation at universities and initiation of large, interdisciplinary groups addressing major problems in

mathematics and computational modeling relevant to advanced materials and processing (National Science Foundation);
- use of fundamental theoretical tools to design structural polymers with desirable properties from the atomic scale (Department of Energy).

Characterization

- accelerate the development of atomic-scale characterization techniques and share facilities (National Science Foundation);
- accelerate research on the immunological response of total joint replacements and bone material interfaces (Department of Health and Human Resources).

Education and Human Resources

- development of broad-based integrated approaches to undergraduate course and curricula development at intermediate and advanced undergraduate college levels, to improve the depth and breadth of materials education for majors in physics, chemistry, materials science, biology, mathematics and the engineering disciplines (National Science Foundation).

APPLICATION-ORIENTED RESEARCH

According to FCCSET, the AMPP is designed to emphasize areas of application-oriented research that build on a strong base. Examples include:

Energy

- exploration of multicomponent systems of semiconductors designed to optimize photovoltaic conversion of solar energy (Department of Energy);
- complete manuals for life cycle analysis and pollution prevention (Environmental Protection Agency);

- development of design, synthesis, and processing technologies for large-area semiconductor alloys with variable band gaps to optimize solar energy conversion (Department of Energy);
- development of advanced functional fluids and greases from oilseed bearing plants (Department of Agriculture).

Transportation

- development and validation, in cooperation with industry, of the technical feasibility of high-temperature, lightweight composites for critical components of future high-speed civil transport aircraft (NASA);
- development of processing parameter measurement techniques to assure quality control in thermal spray coating (Department of Energy);
- expansion of the program in ceramic matrix composites for very-high-temperature loading-bearing applications, to emphasize the improvement of power, fiber, and microchemistry (Department of Energy);
- development of programs with industry to acquire the technical knowledge needed to achieve automated processing of advanced structural ceramics (Department of Energy);
- development of a program, with the transportation industry, leading toward improved reliability and reduced processing costs of lightweight materials for ground vehicles (Department of Energy);

Information/Communications

- development of measurement technology to assure the quality control of chemical reactions during fabrication of electronic printed wiring boards (Department of Commerce);
- expansion of synthesis and processing research on nanostructured materials for electronic, optical and magnetic applications (Department of Energy).

BUDGET TABLE

The table which follows is taken from the AMPP report prepared by FCCSET to supplement the President's budget. Excluded from the figures at agency discretion are classified programs for reasons of national security and some unique mission- driven activities such as the superconducting supercollider and the national aerospace plane. FCCSET estimated that if these excluded programs were counted, the total of federal R&D in materials will be "well in excess of $2 billion."

Table 1
AMPP R&D Funding by Agency (Dollars in Millions)

Agency	FY 91	FY 92	FY 93	FY 93 GROWTH OVER FY 92
DOC	44.5 (33.4)	46.2 (34.2)	48.0 (38.4)	1.8 (4.2)
DOD*	505.9	448.6	431.9	-16.7
DOE*	593.9 (361.8)	602.7 (380.3)	677.9 (432.8)	75.2 (43.5)
DOI	25.0	24.7	23.8	-0.9
DOT	10.0	8.8	15.5	6.7
EPA	3.2	3.5	4.5	1.0
HHS	66.6	76.6	81.7	5.1
NASA	116.3	124.5	153.5	29.0
NSF	246.6 (216.0)	265.9 (243.1)	318.5 (291.7)	52.6 (48.6)
USDA	51.4	57.1	66.1	9.0
TOTAL	1663.4 (1389.6)	1658.6 (1401.4)	1821.4 (1530.9)	162.8 (129.5)

Parentheses indicate total funding excluding major National User Facilities Construction and Operations Cost
**Excludes classified research*

Chapter 26

Mechanical Engineering in the FY 1993 Budget

American Society of Mechanical Engineers
Inter-Council Committee on Federal R&D

James R. Welty, Chairman

Mechanical engineering research and development (R&D) pervades all federal programs. This analysis of the Bush Administration's FY 1993 budget request includes, for the first time, figures for the Department of Transportation. Figures for the Department of Defense are less specific than last year due to limited budget information at the time this report was prepared. This analysis represents programs which involve strong mechanical engineering R&D components.

The agency budget information summarized in Table I provides a perspective regarding mechanical engineering R&D. Three agencies, the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE) dominate, their combined budgets representing 98.8 percent of the total. The DOD alone represents 81.9 percent. Individual agency funding trends are presented in the sections which follow.

TABLE I Mechanical Engineering R&D
(Millions of Dollars)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request
Department of Energy	1,086	1,177	1,142
National Science Foundation	111	120	143
Nat'l Aero. & Space Admin.	6,024	6,851	7,731
Nat'l Inst. of Stds. & Tech.	161	175	202
Environ. Protection Agency	100	95	92
Department of Transportation	134	150	202
Department of Defense		42,711	43,149
TOTAL	7,616	51,279	52,661

The Department of Energy

Mechanical engineering-related R&D in the Department of Energy would decrease by approximately $35 million. Major changes in applied programs include:

- an overall decrease in Fossil Energy R&D from $349,144 thousand to $280,900 thousand
- Coal R&D experiencing a reduction from $279,317 thousand to $153,900 thousand, the largest decrease of any single DOE program
- an increase from $42,952 thousand to $75,300 thousand in Electric and Hybrid Propulsion development
- an increase from $147,750 thousand to $157,300 thousand in Solar R&D.

Energy Conservation R&D would exceed the FY 1992 appropriation by 24 percent, and reflects the direction proposed in the President's National Energy Strategy, released in February 1991. Table II includes energy conservation program budget figures listed in end-use categories.

The request for solar energy programs reflects a modest increase of three percent from $175.5 million in FY 1992 to $181.4 million in FY 1993, including increases of:

- five percent in photovoltaics
- 23 percent in biofuels
- three percent in wind energy systems.

Solar thermal energy would experience a seven percent budget reduction, and the energy storage systems budget would decrease by 13 percent overall.

The FY 1993 funding for Nuclear Energy would be 6.3 percent below the FY 1992 level. This includes decreases of $3.8 million in light water reactor programs, $9.5 million in advanced reactor programs, and $10 million in space power reactor systems. Funding increases totaling $5.84 million are requested for the space exploration initiative and the radioisotope power system program.

The two programs in Basic Energy Sciences with greatest mechanical engineering components would experience an increase of 6.8 percent, primarily to support materials research and biotechnology Federal Coordinating Committee for Science, Engineering, and Technology initiatives.

TABLE II Department of Energy (Thousands of Dollars)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request
Basic Energy Sciences			
Engineering Research	14,759	16,370	18,210
Materials Science	144,593	158,994	169,000
Fossil Energy			
Coal	289,381	279,317	153,900
Gas	15,868	12,571	40,000
Petroleum	59,194	57,256	57,000
Conservation			
Buildings Sector	33,351	36,259	38,780
Industry Sector	73,496	85,312	93,018
Transportation Technologies	76,025	100,629	150,950
Utility Sector	1,261	790	0
Other			
Solar	111,546	147,750	157,300
Geothermal	26,676	26,349	23,500
Hydropower	987	1,043	1,050
Elec. Energy Systems	26,919	29,857	33,200
Energy Storage Sys.	12,369	7,046	6,000
Nuclear Energy	189,794	207,719	194,579
University Programs	9,834	9,998	5,647
TOTAL	1,086,053	1,177,260	1,142,134

National Science Foundation

Support for mechanical engineering research within the Engineering Directorate of NSF would increase by 18.8 percent, exceeding the overall NSF increase of 17.9 percent. Details of the program-by-program budgets, listed in Table III, show significant increases, which is a reversal in the trends of recent years where-in such funding (in real dollars) has been declining.

The total Directorate budget (including education programs, faculty internships, etc.) would increase by 20.9 percent. Engineering would thus exceed 10 percent of the total NSF budget for the first time. Of the $22.6 million increase for research programs, larger percentage increases would go to programs that fund individual projects rather than to the Engineering Research Centers and Industry/University Cooperative Research Centers as in recent years.

Priority areas for Advanced Materials Processing and Biotechnology, with additional research thrusts in Environmental and Manufacturing, may also impact mechanical engineering research.

Funding for Academic and Research Instrumentation and Facilities, requested at the level of $33 million, would be devoted exclusively to Academic Research Instrumentation, with no request for funding in Research Facilities Modernization. Some portions of this should also aid mechanical engineering research programs.

A proposed reduction of 26.1 percent in Graduate Education and Research Development is apparently not a real reduction because of the carryover for this item of $23 million from unexpended FY 1992 graduate traineeship funds.

TABLE III National Science Foundation
(Millions of Dollars)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request
Chemical & Thermal Systems			
Interfacial, Transport, and Separations Processes	8.66	9.40	11.40
Thermal Systems	7.71	8.45	9.89
Fluid, Particulate, and Particle Systems	9.29	10.15	11.39
Design & Manufacturing Systems			
Operations Research and Production Systems (exludes Faculty Intern Program)	5.09	5.37	7.00
Design & Comp.-Integrated Engrg.	5.64	5.82	7.90
Manufacturing Processes and Equipment	9.31	10.87	15.16
Engineering Education and Centers			
Engineering Research Centers	45.86	47.27	53.22
Industry/Univ. Cooperative Research Centers	5.13	6.70	7.20
Mechanical and Structural Systems			
Dynamic Systems & Control	3.59	4.12	4.62
Surface Engrg. & Tribology	2.59	2.55	3.15
Mechanics & Materials	8.04	9.45	11.85
TOTAL	110.91	120.15	142.78

The National Aeronautics and Space Administration

NASA R&D programs which include mechanical engineering will increase approximately 13 percent over FY 1992 levels. In comparison, NASA's overall budget will grow just over four percent. Table IV shows the distribution of funds for NASA in FY 1993, and provides a comparison with previous years' appropriations.

The Space Station Freedom would see an increase of 10.9 percent following restructuring in preparation for Critical Design Review in FY 1993. Mechanical engineering involvement ranges from the systems engineering and integration necessary to coordinate the overall program, to the specific work packages under which habitation/laboratory modules are developed.

Space Transportation Capability Development would increase by $132 million, which includes funding for the maintenance of the engineering and technical base at the manned space flight centers and programmatic funding to support advanced transportation and New Launch systems, the latter a joint program with the Department of Defense.

Space Science and Applications programs would increase approximately 10 percent to $2.98 billion. Materials processing would increase by $76.5 million under this program as experiments are continued to understand fundamental fluids and transport phenomena in preparation for processing in non-earth environments. Earth Science and Applications would increase by $130 million as activities in the Earth Observing System continue in areas of analytical modelling, instrumentation development, and platform design.

Aeronautical Research and Technology would see a 14.9 percent increase as NASA continues its research in aerodynamics propulsion controls and flight systems. In addition, funding would double, to $35 million, for NASA's participation in High Performance Computing, and $80 million is proposed for NASA's portion of the National Aerospace Plane Program, whose current funding level is estimated at $20 million.

TABLE IV National Aeronautics & Space Administration
(Millions of Dollars)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request
Space Station	1,901.0	2,028.9	2,250.0
Space Transportation Development	602.5	731.5	863.7
Space Science & Applications			
Physics & Astronomy	969.2	1,047.3	1,113.5
Life Sciences	137.4	145.8	117.2
Planetary Exploration	473.7	535.6	487.2
Earth Sciences	662.3	738.5	868.8
Materials Processing	102.3	118.8	195.3
Communications	50.5	12.5	4.6
Information Systems	35.7	35.0	40.7
Research Operations Support	92.3	82.3	98.0
Commercial Programs			
Technology Utilization	24.4	32.5	31.7
Commercial Use of Space	63.6	116.1	139.9
Aeronautics & Space Technology			
Aeronautical Research & Tech.	512.0	774.6	890.2
Transatmospheric Res. & Tech.	95.0	20.0	80.0
Space Research & Tech.	286.9	309.0	332.0
Safety, Rehabilitation, and Quality Assurance	33.0	33.6	32.5
Academic Programs	55.1	66.8	71.4
Tracking & Data Advance Systems	20.0	22.0	23.2
TOTAL	6,023.6	6,850.8	7,731.4

National Institute of Standards and Technology

The proposed FY 1993 budget request for NIST includes scientific and technical research and services components totalling $201.9 million, a 27 percent increase over FY 1992 appropriations of $174.6 million.

The largest increase in the appropriate portion of NIST's budget request is for computer systems, an increase of 47.6 percent over the FY 1992 level to $17.5 million. The budget request of $29.3 million for electronics and electrical engineering research, an increase of 15.9 percent, will be for expanded research in semiconductor devices with circuit elements smaller than a micrometer and improved magnetic recording media and retrieval devices. Proposed funding for manufacturing engineering programs is $13 million, an increase of 36.9 percent, and will be used to integrate results on intelligent machines with data management systems. The FY 1993 budget request for materials science and engineering calls for $38.6 million, an increase of 11.4 percent, for maintaining basic materials research and improving the commercialization of laboratory research results. Increases in other areas include:

- $20.9 million (a 10.2 percent increase) for chemical science and technology
- $28.2 million (a 8 percent increase) for physics
- $12.2 million (a 10.4 percent increase) for building and fire research
- $6.8 million, (a 4.7 percent increase) for applied mathematics and scientific computing
- $10.3 million, (a 31.1 percent increase) for technology assistance, and
- $25 million, (a 9.9 percent increase) for research support activities.

TABLE V National Institute of Standards and Technology
(Thousands of Dollars)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request
Scientific & Tech. Research & Services			
Electronics & elec. measurements	21,273	25,311	29,329
Manufacturing engineering	8,266	9,531	13,049
Chemical science & tech.	18,617	18,929	20,853
Physics	25,521	26,129	28,228
Matls. science & engineering	33,039	34,686	38,643
Building & fire research	9,821	11,038	12,184
Computer systems	11,819	11,860	17,509
Applied math. & sci. computing	5,847	6,521	6,825
Technology assistance	7,286	7,885	10,339
Research support activities	19,789	22,712	24,952
TOTAL	161,278	174,602	201,911

The Environmental Protection Agency

Funding for engineering research related to media is listed in Table VI. The overall R&D expenditures for FY 1993 would decrease by approximately five percent from the FY 1992 level of $95.5 million. Significant decreases would be in allocations for hazardous waste, 18.6 percent, and in the Superfund, 12.3 percent.

The FY 1993 air quality program would increase by 30.1 percent to support requirements of the Clean Air Act amendments and the development of advanced materials to examine alternatives to thermal destruction.

Water quality research, dealing with waste water disposal, and drinking water research, involving technologies to remove contaminants from public drinking water systems, would continue being funded at approximately the same levels as in FY 1992.

The decrease in the hazardous waste program is related to a phase-out of hazardous waste land disposal and a reduction in incineration research.

Superfund would increase technical support to EPA's regional offices and states' on-site coordinators. Work on biosystems would increase and a program to develop standard remedies for sites would be initiated.

TABLE VI Environmental Protection Agency
(Thousands of Dollars)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request
Air Quality	12,647	16,003	20,818
Water Quality	7,649	3,789	3,004
Drinking Water	6,257	6,058	6,100
Hazardous Waste	20,219	25,237	20,547
Pesticides	258	244	255
Radiation	2,952	1,435	1,880
Multimedia	2,883	5,290	4,913
Toxic Substances	2,229	2,307	2,361
Superfund	43,717	34,368	30,136
Leaking Underground Storage Tank trust fund program	767	768	768
TOTAL	99,578	95,499	90,782

Department of Defense

The FY 1992 Department of Defense budget shows a decline of seven percent in real terms (adjusted for inflation) from its FY 1992 level. This is in response both to cataclysmic changes in the European communist bloc nations and the attendant changes in U.S. security policy, and to a sluggish domestic economy resulting in pressure on the Administration to make deeper cuts in the FY 1993 defense budget. Continued reduction of the defense budget is planned so that, by FY 1997, the cumulative real decline from the FY 1985 peak will be 37 percent.

The Pentagon's response will result in fewer advanced weapon systems being built. Instead, more emphasis will be placed on research and development of technologies which can be applied to weapons systems if the need for producing them arises. In concert with this policy, the request for R&D funds not tied to specific weapons programs is 9.1 percent greater than in FY 1992, while the total R&D budget request is three percent less than last year.

Table VII presents total figures for R&D within the Department of Defense. More detailed data were not available at the time of this writing.

While mechanical engineering R&D is pervasive throughout all of these programs, it should be noted that the amounts listed in Table VII are for all R&D expenditures within DOD.

TABLE VII Department of Defense R&D
(Millions of Dollars)

	FY 1992 Estimate	FY 1993 Request
Defense - Military Functions		
Basic Research	1,170	1,203
Applied Research	2,995	3,056
Development	35,878	36,251
Energy - Atomic Energy Defense Programs		
Weapons R&D	1,183	1,143
Weapons Testing	458	430
Naval Reactors	600	634
Arms Control Research	181	188
Environmental Restoration Technology	246	245
	--------	-------
TOTAL Defense R&D	42,711	43,149

The Department of Transportation

Trends in the R&D budget for the Department of Transportation clearly reflect the influence of the Intermodal Surface Transportation Efficiency Assistance Act of 1991. This Act calls for federal investment in advanced technology for surface transportation systems and includes initiatives in the areas of Intelligent Vehicle Highway Systems (IVHS), high-speed rail transportation, and the development of magnetic levitation technology. A clear result of this Act is the increase in mechanical engineering-related R&D funding from the FY 1992 level, $150 million, to $211 million in FY 1993 – a 28.9 percent increase.

The Department of Transportation budget, included herein for the first time, identifies those R&D program areas thought to have significant mechanical engineering content.

TABLE VIII Department of Transportation
(Thousands of Dollars)

	FY 1991 Actual	FY 1992 Estimate	FY 1993 Request
Federal Highway Administration			
Intelligent Vehicle Hwy. System		94	100
Nat'l Hwy. Traffic Safety Admin.			
Operations & Research	27,574	43,059	48,522
O&R, Highway Trust Fund	17,316	10,749	10,781
Federal Railroad Admin.			
Railroad R&D	27,568	23,041	26,054
Federal Transit Admin.			
Transit Planning & Research			25,362
University Transp. Ctrs.			6,000
Federal Aviation Admin.			
Aircraft Safety Tech.	61,004	71,423	37,574
System Security Tech.			36,325
Environment & Energy			4,500
Innovative/Cooperative Research			4,777
Research & Special Prog. Admin.	1,001	1,516	1,809
	---------	---------	---------
TOTAL	134,463	149,882	201,804

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Colloquium Proceedings: 1976-1982 and 1984-1991

From 1976 through 1982, the annual AAAS R&D Colloquia were held in June; from 1984 through 1986, in March; and since 1987, in April, following publication of the latest *R&D Report*. The *Proceedings* of these Colloquia were published separately each year and, in general, include the texts of speeches delivered during the meetings and in some cases edited versions of the discussions that followed. (The *Proceedings* of the 1983 Colloquium are included in *AAAS Report VIII).*

AAAS Science and Technology Policy Yearbook, FY 1991

This new volume replaces the Colloquium Proceedings as the second publication in the R&D Budget and Policy Programs's annual series of three publications. It contains most of the major colloquium addresses, as well as both original and previously published articles by leading figures in science and technology policy.

Preliminary Analyses: FY 1979-FY 1984

Prepared by an Intersociety Working Group comprised of representatives of several scientific, engineering and higher education associations, these reports review, in a preliminary fashion, the overall federal budget for R&D, the R&D budgets of several major R&D agencies, and the R&D funding situation in a number of scientific and engineering disciplines. In general, they are published within a few weeks after release of a given year's budget.

Congressional Action on R&D in the Federal Budget: FY 1979-FY 1992

These brief reports, published in the fall, are also prepared in collaboration with the Intersociety Working Group. They summarize the results of congressional action on R&D elements in the federal budget. Their format permits comparison between the President's proposals for a given fiscal year and congressional allocations.

R&D in the 1980s: A Special Report

This report, prepared in the fall of 1988, reviews the history of R&D policy and funding in the Reagan years.

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